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CONTENTS

Welcome the Supply Man

A great many mechanical department men receive representatives of railway supply concerns in their offices, largely because they feel that they cannot help themselves. Speaking generally, we believe this to be a wrong attitude to assume. The representatives of a great many of the companies now manufacturing railway supplies are experts in their particular line and regardless of whether or not they make a sale, they are always willing to give a foreman or a master mechanic the benefit of their knowledge and experience. We know of several instances where mechanical department officers have overcome difficulties which were fast growing beyond control, simply by the assistance of a supply manufacturing company's representative who was sufficiently wide-awake to take a general interest in railway matters and was therefore conversant with the methods which had been pursued on another road in overcoming similar difficulties. Many railway men do not realize the expenditures which are being made by some of these companies for no other purpose than to educate those having to do with the application and use of special devices which have long since proved their value in locomotive and car service. The steam locomotive would never have attained its present position in this country had it not been for the far-sighted co-operation of the manufacturers of railway supplies, and railway men would do well to bear this in mind and receive the representatives of such companies courteously at all times; the time may come when their advice and assistance may be of incalculable value.

The Pennsylvania Test Department

Most of our readers are familiar with the results which have been obtained from time to time on the locomotive testing plant of the Pennsylvania Railroad at Altoona, as well as those obtained on the same plant at the St. Louis Exposition in 1904. Beyond the knowledge of these tests, however, it is doubtful if any great number realize the extent of the work conducted by this department, of which locomotive testing forms but a single branch. The broad scope of this work will, however, be more fully realized after a perusal of the authoritative description of the department and its activities, which is published in another part of this issue. From its humble beginning in 1874 the work of the department has increased at an average rate of over 100 per cent in each year till the number of routine physical tests conducted reached, in 1912, a total of 120,000, the carrying out of which required the services of about 300 employees. The cost of operating this department for one year, $534,000 seems enormous, but the railroad has found it fully justified and indeed this is easy to understand when we consider the undoubted saving in lives and property which are the direct results of the rejection of defective material which would otherwise have been placed in service in cars, locomotives and structures. After all, the cost of conducting the department amounts to but 0.6 per cent of the material inspected and tested, and it may be seriously questioned whether any other road is obtaining anywhere near the same results at a cost even approximating this.

Two July Conventions

The eleventh annual convention of the International Railway General Foremen's Association will be held at the Hotel Sherman, Chicago, July 13-16, 1915, and the American Railway Tool Foremen's Association will hold its annual meeting at the same place, July 19-21. The programs for both of these conventions have been carefully worked up, and if the members will take an active part in the discussion of the various topics, giving their own experience and bringing out that of others, they will not only develop in-

formation of value to themselves, but will add also to the value of the published proceedings. The subject of Roundhouse Efficiency, which is to be discussed at the General Foremen's convention, while one upon which a great deal has been said both in the conventions of this association and elsewhere, is still deserving of the most careful consideration and discussion in order to help toward improved conditions. The difference between the best and the poorest roundhouse practice in this country is very great, and there is still room for much improvement in even the best practice. The possibilities of instructive and economical work in the tool room are brought out in a striking manner by an article elsewhere in this issue describing the methods in use on the Illinois Central. The author of this article is the secretary of the Tool Foremen's Association. Both of these conventions are worthy of a full attendance of shop, roundhouse and tool foremen, and the higher officers of the mechanical department should encourage their subordinates to be present and take part in the discussion.

Underframes Should Be Strengthened

We have repeatedly called attention to the serious condition of box car doors and roofs, which is such as to cause enormous damage to and permit of easy theft of lading from cars. The roof and door problems, however, are by no means the only ones confronting the car man. The underframe, which is the foundation of any car and the main portion of its structure from the standpoint of strength, is sadly neglected in very many cases. The heavy shocks incident to present day service conditions must of necessity be received directly on the underframe, and unless this part of the car's structure is sufficiently strong to withstand them, the body frame work is sure to work loose and the roof to buckle and spring apart at the joints, so that the car provides its lading with practically no protection from the weather. Although some of the cheaply-built modern cars are very serious offenders in this respect, the cars with wooden underframes are the cause of the greatest amount of trouble, and there would seem to be but one remedy, the application either of a full steel underframe or of steel center sills. In a considerable number of cases the latter method has been worked out satisfactorily, resulting in the cars being so strengthened that the cost of repairs and the time spent on the repair track has been greatly reduced. A number of roads have gone to the expense of providing an entire steel underframe on all their more recent wooden cars of higher capacity, and the expense of doing this work has been shown to be amply justified. A point which should be brought home to all concerned with the purchase of new equipment is that even a steel underframe, if improperly designed and poorly put together, will not withstand the shocks of present day switching service, and a reasonable expenditure is demanded in this part of the car structure in the interests of economical maintenance just as much as in the case of roofs and door fixtures.

Car Department Officers and Economy

Why do railway executive officers place experienced men in charge of the car department and then persistently over-ride their recommendations when it comes to purchasing new equipment and making appropriations for repairs? The higher officers who listen to and consistently follow the recommendations of the head of their car department are all too few and it is largely because of this that there are so many freight cars in service which are costing excessive amounts for maintenance. Many of these cars were built according to instructions from the higher executive officers to keep within a certain amount as to first cost, instead of following the recommendations of men familiar with car department conditions, who know that even a slight increase in first cost may mean, in an order of several thousand cars, the saving of an enormous amount in maintenance costs. If the advice of car department officers had been followed in the past the car problem would not be what it is today, but still the policy persists, not only of providing cheap cars but also of providing grossly insufficient amounts for their maintenance. We realize fully that the conditions in railway operation at present require economizing on the part of everyone in every department; but no one can reasonably say that the purchase of cheaply constructed cars, which spend a large proportion of their time out of service undergoing repairs, is economical. When cars have to be purchased it would be far more to the railway's advantage to employ the same amount of money in purchasing a smaller number of well built cars. Such an expenditure would not only result in decreased maintenance charges but in all probability in increased earnings from the cars purchased, because of their ability to make a greater mileage per year. This is one of the numerous points upon which car department officers are qualified to speak and their advice should be given greater consideration by those higher in authority than it now is in many instances.

Consolidation of Mechanical Associations

In his opening address at the June convention of the American Railway Master Mechanics' Association, President F. F. Gaines said, in referring to the possibility of combining all the various mechanical associations in one: "I think that the time has now come when we should have, under whatever title we may choose, one organization only, divided into such sections as may be found advisable. Most of the members of the various associations come under the jurisdiction of the mechanical department of a railroad. It would seem not only advisable but very desirable that some such new association should be formed to take over to a certain extent control of all the others. They need not necessarily meet at the same time; in fact I think it would be better to spread the meetings out as at present, but the executive committee of the supreme association should pass upon the work of the minor associations." Because we feel that this is a matter in which all railway mechanical associations are vitally interested, and that it should be brought plainly to the attention of their officers and members, we wish to repeat a portion of an editorial on this subject which was printed in the *Daily Railway Age Gazette* for June 16, 1915: "Whether a governing body directs the work of the association or a general mechanical association is formed, the different sections meeting together or separately, as the conditions at the time may warrant, is a matter for discussion. There can be no question, however, as to the desirability or even necessity of taking some measure immediately to secure greater co-operation on the part of all of the railway mechanical organizations. This has been realized for a long time, and we have consistently advocated it in our columns. The minor mechanical associations are doing excellent work, yet in the majority of cases they feel the need of more recognition from the larger associations, and would undoubtedly be glad to work with them with the idea of going thoroughly into the details of those questions with which they are most familiar, and making definite recommendations to the major associations for approval and adoption as recommended practice or standard." The actual working out of any such plan could, of course, be determined upon only after careful consideration at representative conferences, but there does not seem any good reason why the various associations should not retain their individuality to a considerable extent, while the centralized control suggested by Mr. Gaines should be the means of eliminating much of the duplication which now occurs, particularly in the minor associations. We believe that the matter of consolidation, or at least of the closer affiliation of all the mechanical associations, should be given careful consideration by their entire membership, for that the requirements of increased efficiency in railroad work demand some such rearrangement there can be no doubt.

Refinement in Locomotive Design

We have had a great deal to say in these columns concerning the refinement of American locomotive design. Much has been said on this subject along the lines of reducing the weight of reciprocating parts by the use of heat-treated and alloy steels. But it must not be thought that the use of special material in order to save weight by the employment of light sections constitutes the only refinement possible in the designing of locomotives. If results comparable with those obtained in Europe, and in some special instances in America, are to be obtained the refinement must be carried out in the design of the entire locomotive. Too much has already been done in the way of increased power merely by increasing the weight. We have nothing to say against the large locomotive, provided it is capable of producing power proportionate to its size and weight; but we have too many cases of locomotives built with very large boilers to insure ample steaming capacity and every other part of the locomotive built proportionate in size, the line of least resistance being followed in obtaining strength, by the simple process of adding metal. The addition of metal in order to gain strength is not what is wanted, but the designing of the various parts so that they will have ample strength at the points where the greatest stresses occur while at the same time there will be no unnecessary metal employed. This line of procedure is absolutely necessary if the weight of locomotives is to be kept in proper relation to the power which they can develop. Furthermore, the adoption of a boiler of large dimensions does not of necessity make it the best boiler for the particular service. Refinement is needed in boiler design as much as in the design of other locomotive parts. Particular attention should be given to the provision of a grate and firebox of the best proportion considered in relation to the boiler as a whole, and to the power requirements of the locomotive. Much of the waste of fuel which it is now the effort of all railway mechanical men to prevent as far as possible, could be avoided if the boilers and fireboxes of some of the locomotives now in service had been properly proportioned when the engines were designed. There are enough locomotives now in service in this country in which refinement has been carried out in the design of every detail to indicate plainly that we need not be behind Europe in the matter of producing a horsepower with the least expenditure of water and fuel and the smallest amount of dead weight.

NEW BOOKS

Proceedings of the American Institute of Electrical Engineers. Bound in paper. 390 pages, 6 in. by 9 in. Illustrated. Published by the American Institute of Electrical Engineers, 33 West 39th street, New York. Price $1.00.

This is the May number of the Proceedings of the American Institute of Electrical Engineers, and contains a number of interesting and valuable papers. These include papers on direct current control for hoisting equipment in industrial plants, the classification of alternating current motors, provisional specifications for insulator testing and many others. The book is well illustrated, the half-tone illustrations being on special coated paper and of a particularly high order.

Resuscitation. By Charles A. Lauffer, M.D., medical director, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. 90 pages, 4 in. by 6½ in. Bound in cloth. Published by John Wiley & Sons, Inc., 432 Fourth avenue, New York. Price 50 cents.

This book originally appeared in 1913, and it has met with such favor that a second edition has now been published. It deals with the resuscitation of persons whose respiration is suspended either from electric shock or asphyxiation from various causes frequently met with under modern conditions. It gives a complete outline of the so-called prone pressure method of producing artificial respiration, which is considered the best manual method of resuscitation, in that it may be carried out by one person without assistance. The process is comparatively simple, and a thorough understanding of it by all persons employed in work subjecting them to the possibility of electric shock or asphyxiation would undoubtedly be the means of saving many lives which are lost during the interval required to call a doctor or secure mechanical means of resuscitation.

Universty of Illinois Bulletins, Bound in paper, 5½ in. by 9 in. Published by the University of Illinois Experiment Station, Urbana, Ill.

This is volume ten of the bulletins issued by the Engineering Experiment Station of the University of Illinois, most of which are noticed from time to time in these columns. This volume contains bulletins 68 to 74 inclusive, the subject of No. 68 being The Strength of I-Beams in Flexure, while that of No. 69 is Coal Washing in Illinois, No. 70 the Mortar Making Qualities of Illinois Sand, No. 71 Tests of Bond Between Concrete and Steel. No. 72 Magnetic and Other Properties of Electrolytic Iron Melted in Vacuo, No. 73 Acoustics of Auditoriums and No. 74 The Tractive Resistance of a 28-Ton Electric Car.

Machine Shop Management. By John H. Van Deventer, M.E., associate editor, American Machinist. 365 pages, 4 in. by 6¾ in. Illustrated and indexed. Bound in flexible leather. Published by the McGraw-Hill Book Company, Inc., 239 West 39th street, New York. Price $2.50.

This is the first edition of a handbook, which it is stated has been written with the definite purpose of making available to all machine shop executives and men in training for machine shop executive positions a useful book on the study and solution of problems in management. Matters pertaining to organization are considered and committee plans and suggestion systems as well as apprenticeship are described. The functions of the drafting department are taken up and a section is devoted to equipment control, which is considered under such heads as the selection of equipment, machine location and the arrangement and standardization of machines and tools. Other sections deal with matters pertaining to quantity and quality, time keeping, rate setting, compensation and wage methods, etc., as well as traffic control and the causes of delay in shipment. The last section of the book is devoted to shop hazards under such heads as safety, mechanical safeguards, fire prevention and sanitation. The book is printed on thin paper and is of a handy size for carrying in the pocket.

Oxy-acetylene Welding and Cutting. By C. H. Burrows. 134 pages, illustrated. 6 in. by 9 in. Bound in cloth. Third edition. Published by the Vulcan Process Company, Minneapolis, Minn. Price postpaid, $1.50.

Two editions of this book have already appeared, and in the third a number of revisions have been made. It is not intended as a comprehensive treatise of a technical nature, which would necessarily include a large amount of material of little practical use to those whose only requirements are the ability to properly handle the apparatus and the skill to successfully perform the various operations to which the oxy-acetylene flame is adapted. Only such theoretical matter has been included as is necessary to a clear understanding of the action of the oxy-acetylene flame and of the appliances usually met with in welding plants. Three chapters are included on the chemistry of acetylene combustion and the physical laws of gases, together with a brief consideration of the units of heat measurement and the expansion of metals. Aside from a brief chapter on metals and their properties the remainder of the book is devoted entirely to practical matters, including descriptions of the various appliances used in gas welding and cutting. At the close of the book are a number of useful tables, several of which deal with the cost of oxy-acetylene welding and cutting. The book was originally prepared for the instruction of users of Vulcan equipment, but much of the material which it contains is of general application.

PENNSYLVANIA RAILROAD TEST DEPARTMENT

The New Physical and Chemical Laboratory at Altoona and an Outline of the Extent of the Work

BY C. D. YOUNG
Engineer of Tests, Pennsylvania Railroad, Altoona, Pa.

Endeavoring to promote the safety of passengers and employees on its lines by minimizing or eliminating, if possible, all accidents traceable to defective or unsuitable material, the Pennsylvania Railroad has found that the quality of the material purchased for use in rails, bridges, cars and locomotives must be carefully scrutinized. Control over the quality of supplies is secured by the aid of specifications, which are based upon careful consideration of the materials available for the various uses of the railway, and by research work tending toward the development of new materials and devices, or improving those which are in general use. Neither the reputation of the manufacturer nor a superficial inspection of the materials offered has been found to be a sufficient safeguard in the purchase of supplies, since frequently the manufacturer himself has no positive knowledge of the strength or other physical properties of the iron, steel or other metals, nor the purity of many of the articles offered for sale.

An organization with laboratories at a central point is an essential in promoting the work of thorough inspection, the importance of which is unquestioned. With this inspection, accidents to the traveling public and the employee have been reduced, and efforts in the future will be towards their further reduction. It is desirable, therefore, that the public be fully informed as to the facilities provided by one of the largest railroad companies for making tests of all its supplies and conducting investigations with a view of obtaining the best materials which can be commercially furnished.

The Department of Tests of the Pennsylvania Railroad—the first of an American railroad—has grown in the following way:

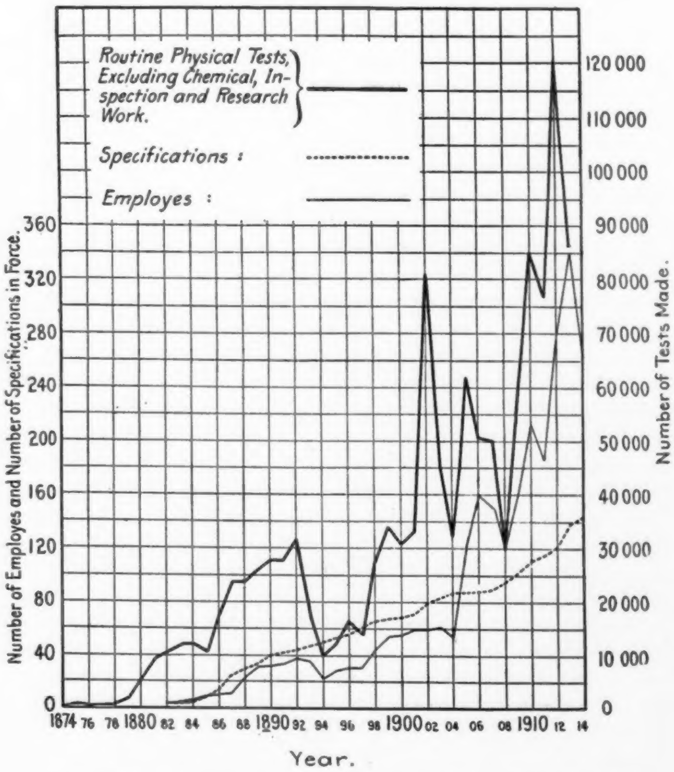
In 1874 there was established at Altoona, a department of physical tests, the organization of which was placed under the direction of Theodore N. Ely, then superintendent of motive power. The first testing machine was purchased during the early part of the year. It was of 50,000 lb. capacity and was furnished by Fairbanks and Ewing. The first test was made on April 2, 1874.

In the beginning, the testing work was conducted by the master mechanic of the Altoona shops, but in August, 1874, the department of physical tests was placed in charge of John W. Cloud, who became the first engineer of tests. A chemical laboratory, under the direction of the late Dr. Charles B. Dudley, was added in the autumn of 1875. Research work for the improvement of rails was begun, and the investigations and accumulation of experience, which later made possible the preparation of a series of "Standard Specifications," had their start.

It was not until 1879, or five years after the beginning of the testing of materials, that the physical and chemical departments were provided with a separate building. This building was a one-story frame structure, 25 ft. by 45 ft. These quarters were soon abandoned, however, and until 1914 space was made available in a part of the shop office and storehouse building, where the departments finally occupied 15,476 sq. ft. of floor area on four floors. That the growth of the departments has been rapid is also evidenced by the diagram, which shows the number of employees, the number of routine physical tests, and the number of standard specifications in force for each year from 1874 to 1914. The quarters having become congested in the past few years, a new building with a floor area of 41,000 sq. ft., was begun in 1913 and completed in 1914. Thus, in 35 years the requirements of the departments, as shown alone by the floor space occupied, have increased more than 35 times; or, there has been an average increase of over 100 per cent for each year since the work began. The growth of the test department and laboratory has been very much more rapid than the increase in tonnage hauled, or the extension of the general business of the railroad. The reason for this is that there was almost as wide a field for the application of specifications, and the inspection and testing of materials, in the beginning as at the present time.

THE NEW BUILDING

The new building at Altoona which has just been occupied is constructed of reinforced concrete, the reinforcement being of twisted bars. Structural steel cores are used in the con-



Growth of the Department of Inspection and Tests on the Pennsylvania

crete columns. The whole exterior is finished in red brick and red terra-cotta. It is arranged with a central service portion consisting of the middle bay which contains a stairway and an electric elevator, giving access to all parts. On the basement floor of the service section there is a receiving room for materials. This room communicates with the elevator for the distribution of small samples to the different sections of the building, while large pieces may be lifted to the physical-test section by means of a ten-ton traveling crane with a hatchway in the main floor. There is a machine room in the basement and in this all of the metal test specimens are prepared. On this floor there are two large fireproof vaults for the storage of letter files and the like, and a room for chemical stores.

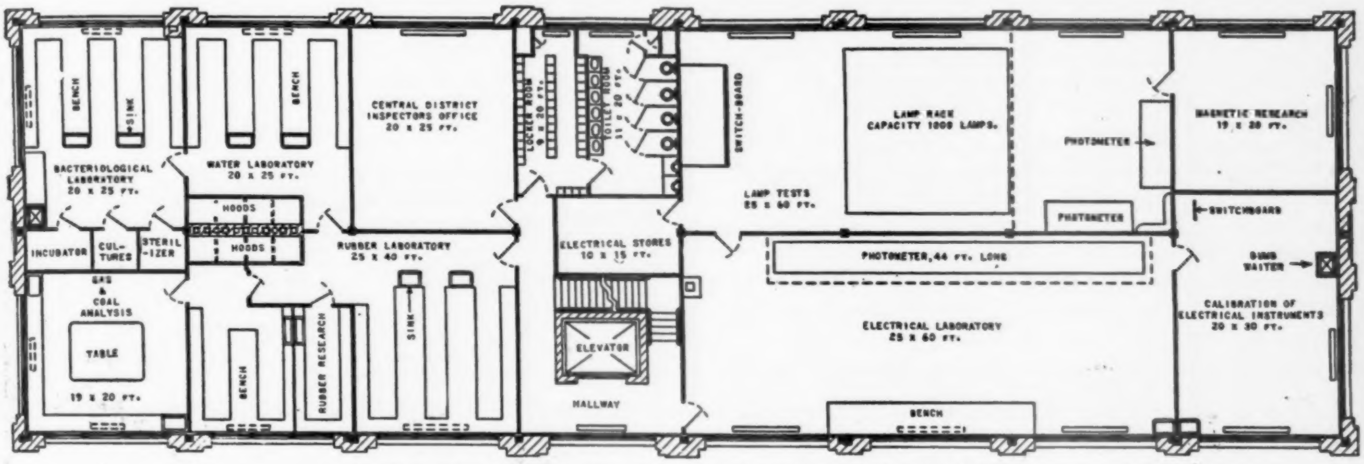
*From a paper read at the annual meeting of the American Society for Testing Materials, Atlantic City, N. J., June 22-26, 1915.

The first or street floor is devoted to physical tests. It contains a physical laboratory with five universal tension and compression testing machines, the largest of which has a capacity of 1,000,000 lb., and all are served by the traveling crane. On this floor are separate sections for oil, cement and lagging, hose, rail, miscellaneous and heat-treatment tests.

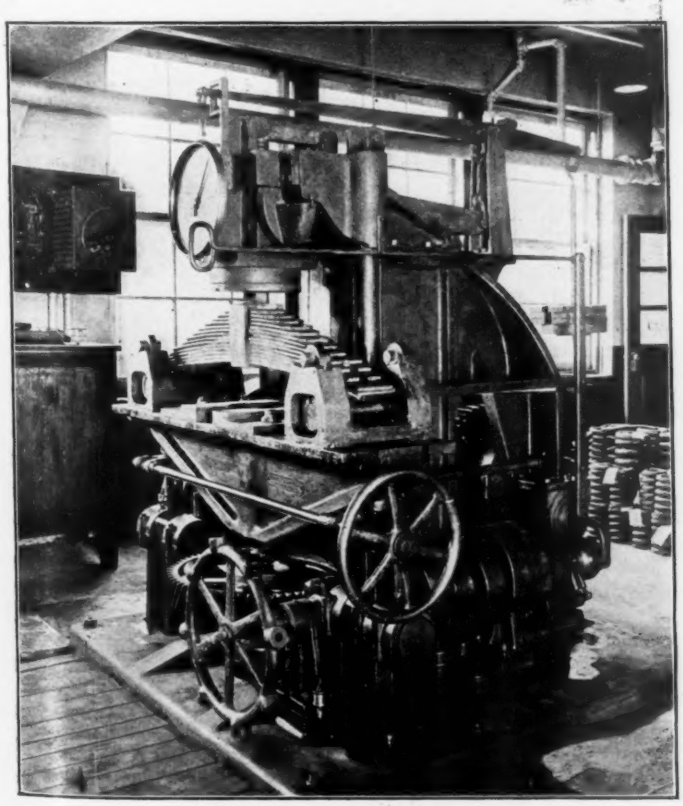
The second floor is used for office, locker and toilet rooms, the south end being occupied by the office force of the engineer of tests and the north end by that of the chief chemist.

The third floor is divided into laboratory rooms for bacteriology, rubber, water and gas analyses, photometry and lamp tests, and the calibration of electric instruments.

The whole fourth floor is used as a general chemical laboratory with a separate chemical balance room. The central bay is extended up to form a fifth floor, which comprises a photographic studio and dark room, while the roof of the remaining portion of the building is used for experimental work and tests where exposure to the atmosphere is required.



A Typical Floor Plan in the New Building; This Is the Third Floor



Spring Testing Machine

Direct lighting with tungsten lamps is the system of illumination. "Abolite" metal reflectors are used in the basement and on the first floor, with "Pyro" glass reflectors on the second or office floor. In the chemical laboratory, where metal would be injuriously acted upon by gases, "Holophane" glass reflectors are in use. All of the lighting and power conduits were placed in the floors before pouring the concrete. Telephone, dictaphone and buzzer systems are installed in the floor conduits, and in addition great flexibility is possible in the location of these fixtures by the use of a chair rail around the walls of each room, the chair rail having three separate grooves for wires.

The building is heated by direct steam radiators with a single pipe system, and the radiators are placed under the windows. A hot water service, with a heating and circulating tank in the basement, is provided. The gas, steam, air, water and hydraulic lines are of open work, and all pipe risers are in a common conduit in the central service bay of the building.

The interior of the building is finished in natural chestnut throughout, with the exception of the office rooms, which are finished in imitation mahogany. All interior doors and partitions are glazed. The floors, with the exception of the basement, where the floor is of concrete and the physical laboratory where it is of wood on concrete, are of magnesium-cement composition.

It is noteworthy that the building was constructed and equipped complete within the original estimates and appropriation. The building itself cost about $150,000. An estimate of the value of the contents is, for the physical laboratory, $100,000; and for the chemical laboratory, $25,000. With equipment complete, the investment is about $275,000.

PHYSICAL LABORATORY

Among the machines and apparatus that compose the equipment of the physical laboratory, there are the following:

- Five universal tension and compression testing machines, one of 1,000,000, two of 300,000, two of 100,000-lb. capacity;
- One vibratory endurance spring testing machine of 75,000-lb. capacity;
- One 43-ft. drop-testing machine;
- Two vibrating staybolt testing machines;
- One Brinell hardness testing machine;
- One 2,000-lb. cement testing machine;
- One horizontal microscope, with camera for metalographic work;
- One grinding, buffing and etching outfit for the preparation of samples for microscopic work.

In the machine room, where the sample test specimens are prepared, the following tools are used:

- Two 14-in. engine lathes;
- One 12-in. drilling lathe;
- One 24-in. shaper;
- One 24-in. radial drill;
- Two milling machines for specimens;
- One 30-in. cold saw;
- Two motor hack saws;
- Two tool grinders.

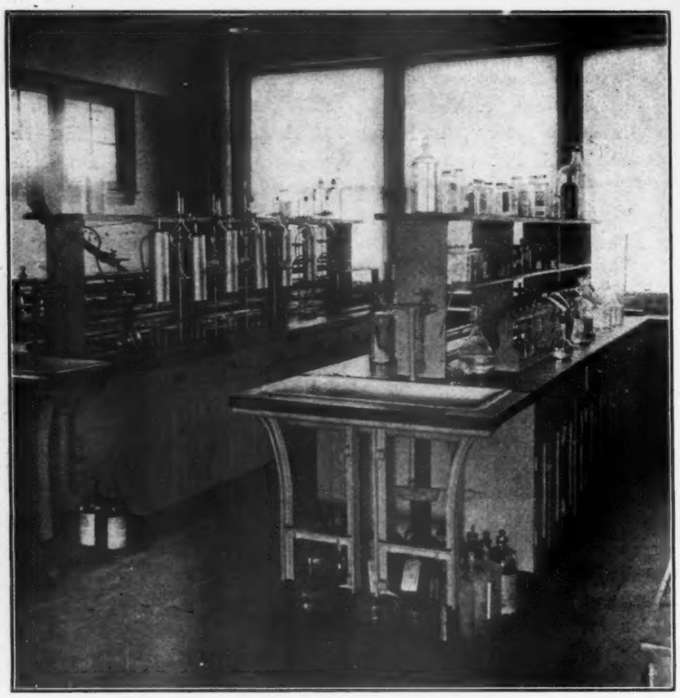
For the work in testing air brake, signal and tank hose and

other miscellaneous tests including steam and hydraulic gages, there are:

- Six rubber stretching machines;
- One friction test rack for rubber;
- One hose mounting machine;
- One vibrating test rack for hose;
- One continuous test rack for rubber;
- Four tension testing machines for rubber;
- One stretching machine for rubber insulation;
- One spring micrometer machine;
- One vacuum gage testing machine;
- One arbor press specimen cutter;
- One hydraulic gage testing machine, capacity 25,000 lb. per sq. in.;
- One dead-weight gage testing machine, capacity six gages;
- One wigling testing machine for hose;
- One bumping testing machine for gages;
- One whipping testing machine for gages;
- One hydraulic machine for testing gage glasses.

The materials for test, including samples which have been obtained by the inspectors at outlying points and those sent to the department by the shops, are brought into the building through the receiving room. They are distributed throughout the building from that point, the metal specimens going to the machine room in the basement for preparation, then to the physical laboratory for tension, compression, vibratory or other tests, and to the chemical laboratory for analysis.

Rubber, Air Brake Hose and Miscellaneous Laboratory.—The extent of the work of this department is indicated by the fact that the needs of the railroad are about 635,000 pieces of air brake hose per year. There are now being installed machines for air brake, signal and tank hose, and other miscellaneous tests, including steam and hydraulic gages, and gage glasses for boilers and lubricators.

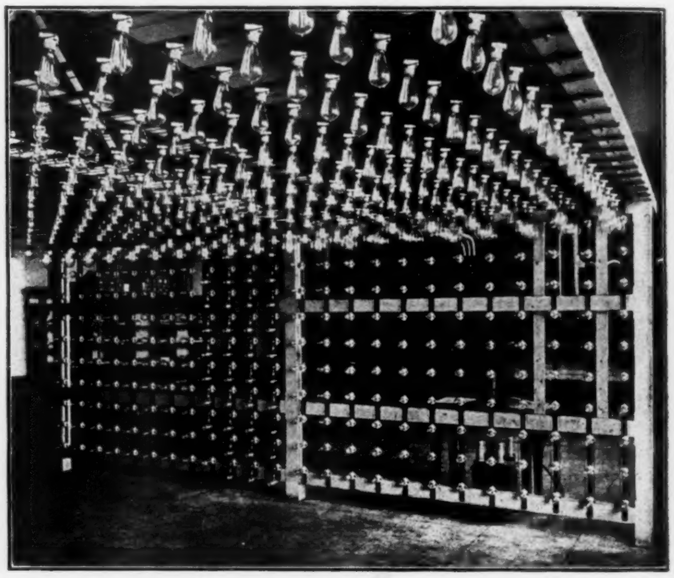


Water Laboratory, Where Chemical Examinations Are Made of Drinking and Boiler Feed Waters

Heat-Treatment Laboratory.—This department, on the first floor, is for the development of standards in the heat-treatment of metals during the process of their manufacture for use in railway equipment. Investigations are carried out to study the effect of various heat treatments on a large variety of carbon and alloy steels. They are also made to determine the properties of non-ferrous alloys, including the co-efficient of expansion. Shop-manufactured locomotive and car springs, involving as they do a form of heat-treatment, are sampled and tested regularly to determine their acceptability for service.

Large castings of various kinds have been heat-treated by this department with the aid of outside facilities with a gratifying degree of success. The effect of chemistry and heat-treatment upon the endurance of materials subjected to repeated stresses is tested out by revolution and vibration tests, including vibration tests on complete springs. Rails, splice bars and tie plates are heat-treated to study the increased service it is possible to secure. The effects of heat-treatment are noted and a wide range of working conditions are applied on a variety of high speed tool steels to ascertain the best chemical characteristics.

Investigations are made on various types of fireproof material for the purpose of maintaining a high standard. The testing of felt and insulating papers used for lining refrigerator cars has been made necessary by the large variety of materials of this kind on the market, the keen competition among manufacturers, and the ease with which the highest grade and best material can be closely imitated by cheap and inferior products. This laboratory is equipped with an insulated room and electrical heating arrangements for this work, the tests being designed to represent as nearly as possible the service conditions to which these materials would be subjected. Temperature measurements are made of various types of refrigerator-car construction by means of resistance thermometers. Aside from the measurements of high temperatures in the laboratory, periodic calibrations are made of the various pyrometers. The heat-treatment department in general carries on a large variety of special work, and there is but little that falls without its range of possibilities even to the extent of heat-treating glassware.



Lamp Test Rack with a Capacity of 1,000 Lamps

ELECTRICAL LABORATORY

Lamp Tests.—On the third floor the equipment for lamp tests consists of three photometers, a lamp test rack of 1,000 lamps capacity, with switchboard, transformers and potential regulator equipment. This work was taken up in 1902, with a view of obtaining data for the preparation of specifications to secure uniformity in the ordering of incandescent lamps, and the maintaining of sufficiently high standards. It consists mainly of life tests of lamps at abnormal voltages and tests for the efficiency of illumination, as well as the investigation of new developments in the general field of illumination as applied to railway work.

Standardization of Instruments.—A division of the electrical laboratory is employed in investigations and development work along electrical lines, and the standardization of electrical instruments. Part of this work is done at the laboratory, and part of it, when necessary, at other points, by laboratory men.

The character of the work may be judged from the following examples upon which comprehensive reports have been made:

An investigation of electrolysis in systems of underground metallic structures;
Tests and investigations of the construction of various makes of transformers;
Tests of various makes of primary and secondary battery cells;
Oscillographic tests for linear and angular velocity, wave forms, etc.;
Investigations of special cases of electrical troubles;
The development of an electrical method of measuring the hardness and homogeneity of steel.

Matters such as these are reported on and recommendations made. Electrical instruments are sent in from all points on the Pennsylvania system to this department for calibration and repair, and men from the laboratory are sent out to inspect and check electrical instruments on switchboards at the various power plants, and at other points.

Interior of the Laboratory Car

LABORATORY AND ROAD ASSISTANTS

A large room on the second floor is provided for the force of laboratory and road assistants coming under the direction of the foreman of road tests and special tests. The duties of these men are varied, and include tests of locomotives on the road or tests of equipment with special devices; the tonnage rating of trains and the following up of all experimental appliances which are put into service for test purposes.

The fifth floor has been arranged for photographic work, consisting largely in making prints of metal sections, photomicrographs of steel rails forming a large part of these. Photographs of parts which have failed in service are also made for convenient preservation and study. The photographic work requires the services of two men and about 25,000 prints per year are made.

CHEMICAL LABORATORY

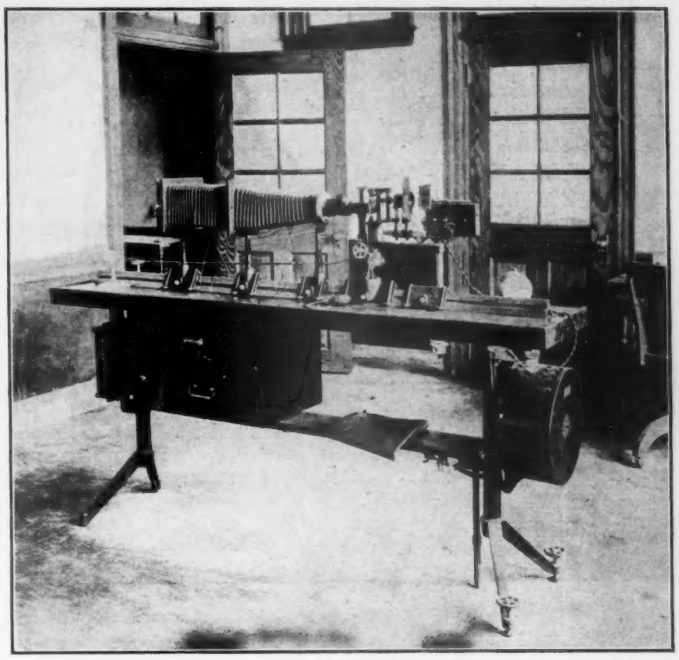
Metallurgical Work.—The main chemical laboratory on the fourth floor is divided by the central balance room, into two departments, the larger one of these being devoted exclusively to metallurgical chemistry. In this department methods are developed for the determination of the elements in plain-carbon steels, alloy steels, and non-ferrous alloys used for bearing backs and linings, packing-ring metal for different purposes, etc. Data are obtained leading to the development of specifications for this class of products, and samples of shipments are analyzed to determine whether they are acceptable under the specifications adopted. This steel laboratory has facilities for analyzing 100,000 samples per year.

Miscellaneous Work.—The smaller of these two laboratories is for work of a more general character, being used for the examination of fuels, the development of specifications for paint products, lubricating and burning oils, boiler compounds, lacquers, plush, car cleaners, cutting compounds, belt dressing, polishing compounds, hydraulic-jack liquids, fuses, track caps, fire-extinguishing preparations, the recovery of used or wasted products, etc.

In both of these laboratories much time has been spent in the examination of broken or "failed" parts of equipment, in an effort to determine the cause and with a view to the prevention of accidents which aside from the money losses, might result in injuries or loss of life.

Certain food products used in the dining car service are also examined here at times; many other miscellaneous investigations are made, as of conditions which may have led to loss from the damage of freight in transit, and to so establish methods for preventing such loss. During the past year a considerable amount of work has been devoted to the chemistry of tunnel air in connection with the installation of ventilating systems. The total list of activities touched upon would be too long for enumeration in an article of this character.

The chemical analysis of rubber compounds has been studied and much experimental work done in perfecting a method whereby material of this kind can be bought on specifications which define and limit its chemical properties. At present there is in force a specification for high-grade rubber insulation. Samples from all shipments are analyzed, as well as some other rubber compounds. At the same time experimental work is being carried on to improve the method of analysis, and to devise others so that specifications may be drawn covering the chemical properties of other grades of rubber materials.



Metalographic Laboratory

Manufacturing Laboratory.—A manufacturing laboratory, which might be called a small factory, is maintained in a separate building which is under the direct supervision of the chief chemist, and new products are manufactured in this until such time as it is found advisable to purchase them from "outside" manufacturers.

Laboratory Car.—In addition to the steel-rail work at Altoona a laboratory car has been built to be moved, as required, to that point where steel rails in process of manufacture are to be

inspected. The object in equipping this car is to make chemical analyses of the finished rails at the mills by a force of chemists under the chief chemist. This, it is expected, will avoid delays which at times occur in the operation of the mills, and are impossible to avoid without the facility of a suitable force at hand at the time and when the rolling is taking place, in order to keep up with the chemistry requirements of the company's specifications. The car is equipped with furnaces for combustion and all other necessary apparatus for general chemical work in connection with the inspection of steel rails.

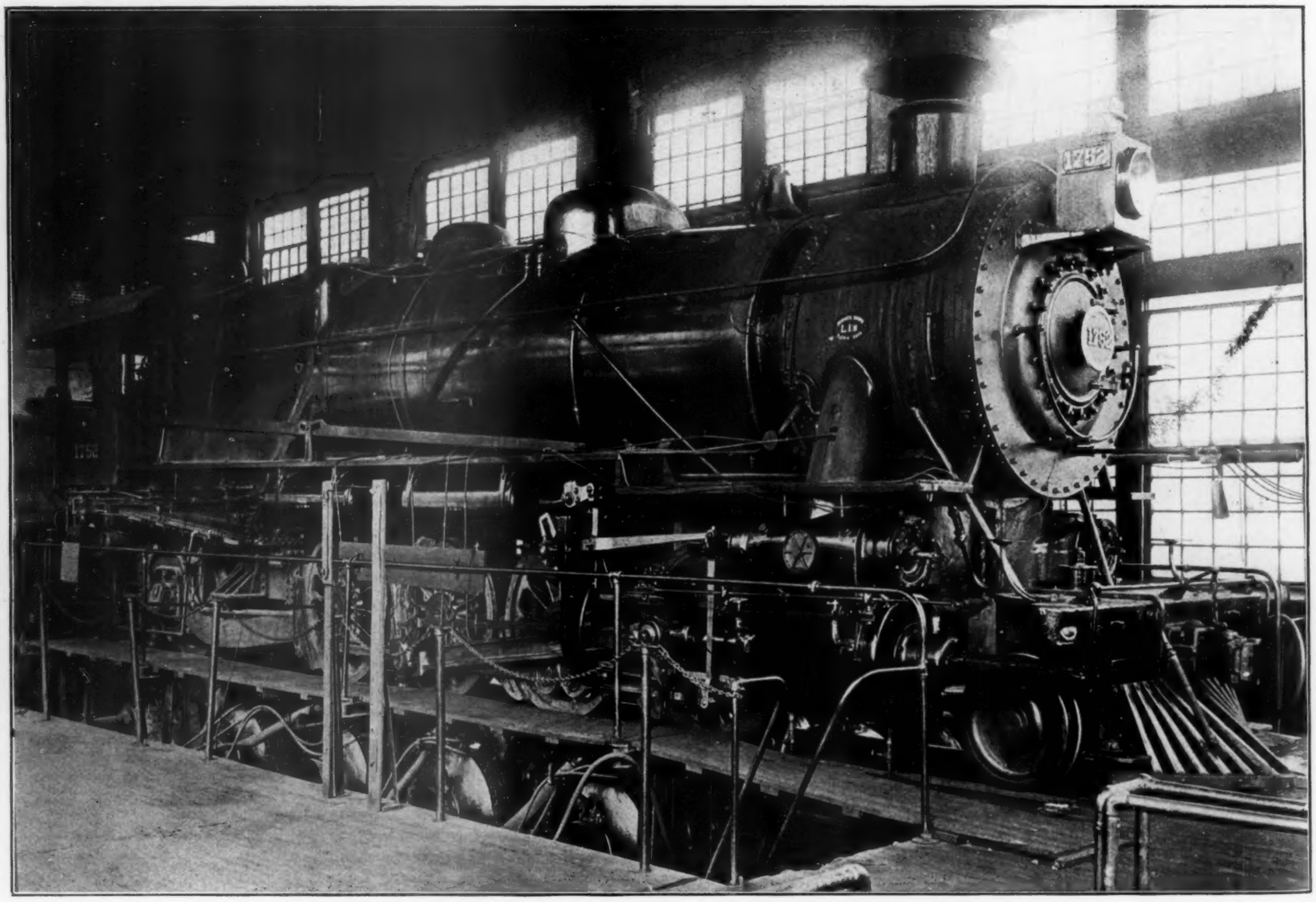
Bacteriological Laboratory.—When the department of chemistry was established, problems were frequently presented which applied chemistry could not solve satisfactorily. It was found, for example, that a chemical examination of water might show the presence of organic constituents, but it was impossible to tell the source of these. A water might contain a large amount of organic material of vegetable origin and yet not carry any infectious material which would likely give rise to disease, while other samples low in organic constituents were believed to carry infectious germs which might render their use very dangerous to employees or patrons of the road.

It was also found necessary to supervise certain sanitary matters and to disinfect cars, offices and waiting rooms under certain conditions, but it was not known what disinfectants were destructive to specific disease-producing bacteria. Manufacturing concerns were offering various disinfecting preparations, but the officers of the company had no means of determining which ones were efficient and the problem could not be solved by chemistry alone. These questions were considered so important that it was decided that a division of bacteriological chemistry was necessary, and on November 1, 1899, such a laboratory was established.

The work in bacteriology and water analysis has increased constantly, and at the present time four men are employed in the laboratory. The department co-operates with the surgeon general of the United States in the enforcement of the quarantine regulations of 1913, which require that railroad companies shall furnish wholesome drinking water and proper ice supply to passengers using their cars. Water which contains anything indicative of injurious contamination is not permitted to be introduced into the drinking containers of a Pennsylvania coach.

The department regulates the standardization of disinfectants and issues instructions concerning their application for the protection of passengers and employees, as well as the disinfection of stock cars. Special care is taken to prevent any infected employees from coming in contact with the public.

In 1914 bacteriological and chemical examinations were made of 609 samples of drinking water. There were 3,112 bacteriological examinations of pathological specimens, submitted by the relief association physicians. The total number of bacteriological examinations was 3,621, or an average of more than ten per day.



A Mikado Type Locomotive on the Testing Plant

In addition, this department has under its care the examination of boiler feed waters and the formulation of methods for their treatment. In 1913, examinations of 287 boiler feed waters were made, while in 1914 the number was 282.

OTHER EQUIPMENT

As part of the equipment of the test department there is a dynamometer car which was built in 1906, and is the fifth of a series of such cars which have been in use on the Pennsylvania Railroad. There is also the locomotive testing plant which is located adjacent to the test department building. This plant was erected in 1905, after having been in use at the St. Louis Exposition in 1904, and is operated by a force of 26 men.

There is being installed in a separate building a brake shoe testing machine which will be the first of its kind, in that it will have two dynamometers of 4,000 lb. capacity, which will make it possible to obtain the co-efficient of friction of brake shoes when two shoes are applied to a single wheel (clasp brake conditions). The car wheel will run upon an idler wheel.

EXTENT OF WORK; AND ORGANIZATION

The scope of the work now embraced by these departments coming under the jurisdiction of J. T. Wallis, general superintendent of motive power, at Altoona, can be better appreciated when it is understood that the cost of the materials covered by the inspection and tests, and entering into the construction of the railroad rolling stock and track, in 1913 amounted to $82,119,480, while the cost of operating the test department and chemical laboratory for the same year was $534,060. For an approximation and using these figures, it is interesting to observe that the total cost of operating the departments, including all additional work and inspection, is about 0.6 per cent of the cost.

The year 1913 was perhaps a record one for the test department and laboratory, and the extent and variety of the work of the departments can be shown by a few examples for that year. There were 61,148 separate reports of material tests issued by the test department. In the physical laboratory, while no record was kept of the number of samples examined, 138,886 tests were made, representing quantities as follows:

Of bar iron 149,863,693 lb. were tested and 6,246,611 lb. rejected; of staybolt iron, 15,385 tests representing 8,301,960 lb. were made; of cement, 29,231 tests were made, representing 587,900 bbl., of which 13,600 bbl. were rejected; of wheels, 310,381 were inspected, and 1,213 were rejected; of axles, 164,810 were tested and 8,035 were rejected; 290 samples, representing 56,322 yd. of plush, were tested; of air brake hose, samples representing 634,807 were tested and 84,826 of these were rejected.

In the chemical laboratory, during 1913, a total of 57,309 samples were analyzed, involving about 286,545 determinations.

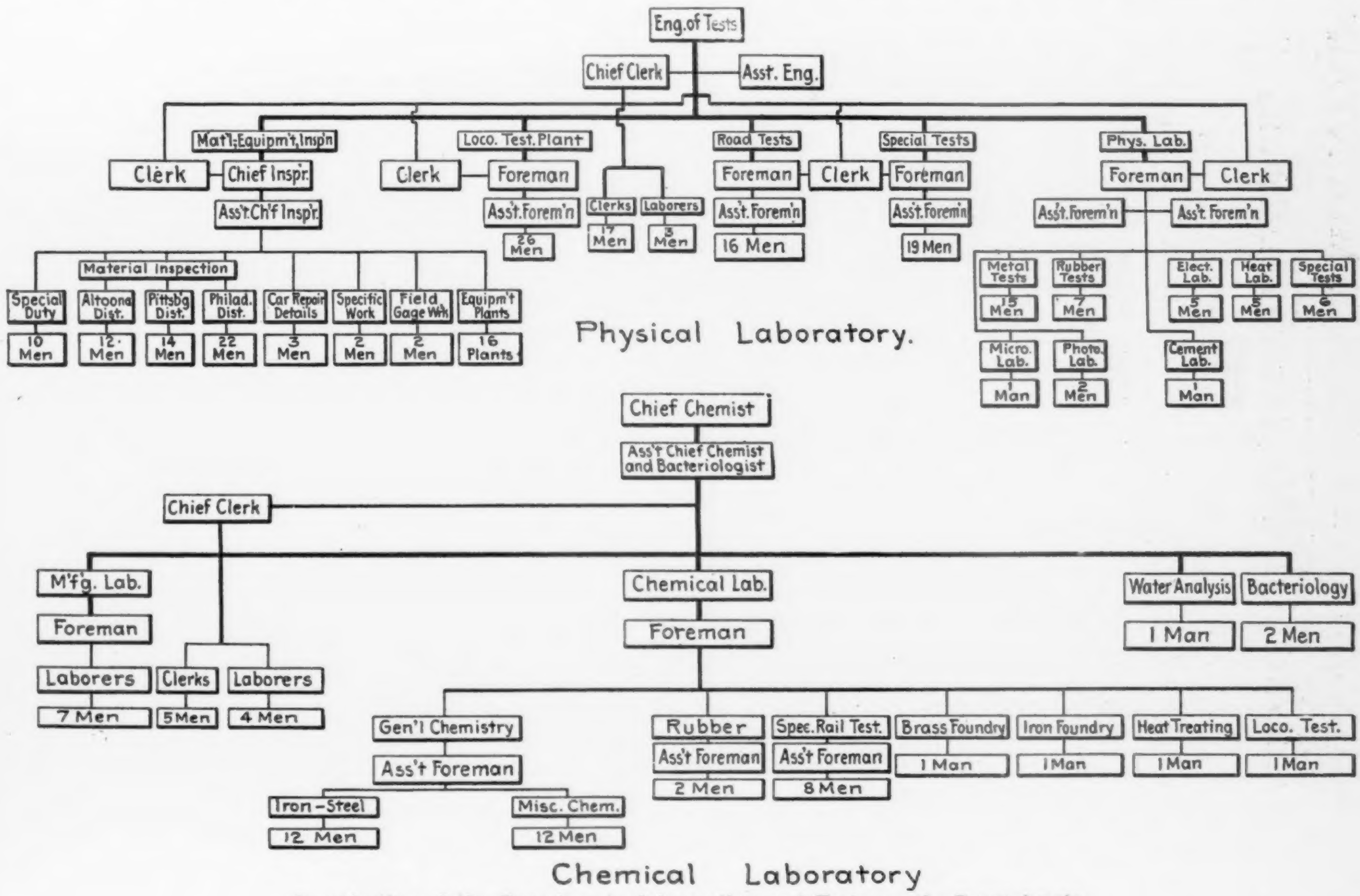
There are 85 items, ranging from asphaltum to zinc, which are now bought under specifications and which must be passed upon by the test department or the chemical laboratory.

During 1913 there were inspected, while building at manufacturers' works, 24,966 freight cars, 343 steel passenger cars, and 190 locomotives. The value of the materials rejected through the test department in 1913 was for the physical laboratory, $776,928; and for the chemical laboratory, $65,767.

As outlined in the diagram of the organization, the inspection at the manufacturers' works and the collection and forwarding of samples to Altoona is carried out under the direction of the chief inspector, with permanent resident inspectors and forces for the central district at Altoona, the western district at Pittsburgh and the eastern district at Philadelphia. In addition, when equipment is being built at outlying points, temporary inspection forces are maintained there during the progress of the work.

As previously stated, the work of the department began under the direction of John W. Cloud. In May, 1879, he was appointed the first engineer of tests and continued under that title until July, 1886, when he succeeded to the office of mechanical engineer, retaining control of the test department. Axel S. Vogt, the present mechanical engineer, succeeded Mr. Cloud in March, 1887. The work of the department under the mechanical engineer was in direct charge of W. O. Dunbar from July, 1886, to July, 1893. From the latter date to July, 1903, the assistant mechanical engineer had direct charge of all the work of the department. During this latter period the assistant mechanical engineers were A. W. Gibbs, from July, 1893, to August, 1902, and W. F. Kiesel, from the latter date until July, 1903. In August, 1903, E. D. Nelson was appointed engineer of tests, and in September, 1911, was succeeded by the writer.

Two men have been in charge of the chemical laboratory, Dr. Charles B. Dudley from November, 1875, until his death, December 10, 1909; since then Dr. F. N. Pease has held the position.



Organization of the Department of Inspection and Tests on the Pennsylvania

EXAMPLES OF RECENT LOCOMOTIVES OF THE MOUNTAIN AND PACIFIC TYPES

ARRANGED IN ORDER OF TOTAL WEIGHT

Type	4-8-2	4-8-2	4-8-2	4-8-2	4-8-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2
Name of road	R. I.	C. & O.	G. N.	Seaboard	M. P.	C. & O.	Exper.	N.Y.C.	L. V.	G. N.	Intercolonial	L.&N.	P.R.R.	D.&H.	A.T.&S.F.	R.I.	C.C.&O.	A.T.&S.F.
Road number or class	999	316	1755	200	5201	182	50,000	3426	2010	1461	446	2215	K4s	608	3600	961	154	3518
Builder	Amer.	Amer.	Lima	Amer.	Amer.	Amer.	Amer.	Amer.	R.R.Co.	Lima	Mont.Loc.	R.R.Co.	R.R.Co.	Amer.	Baldwin	Amer.	Baldwin	Baldwin
When built	1913	1911	1913	1915	1913	1914	1911	1911	1913	1914	1914	1914	1914	1914	1914	1913	1914	1914
Tractive effort, lb.	50,000	58,000	61,900	47,800	50,400	46,600	40,800	30,900	41,600	40,500	32,400	31,720	41,850	40,730	41,000	40,250	46,000	34,000
Weight, total, lb.	333,000	330,000	326,000	316,000	296,000	312,605	269,000	269,000	262,160	251,200	243,500	232,000	308,900	293,500	288,700	281,500	280,300	277,700
Weight on drivers, lb.	224,000	239,000	218,000	210,500	208,000	191,455	172,500	171,500	161,940	150,700	154,000	138,000	201,800	191,000	172,550	174,500	176,900	165,100
Weight on leading truck, lb.	57,500	44,000	50,000	53,000	48,000	56,675	49,500	50,000	49,420	55,000	45,500	24,550	53,600	47,500	59,950	53,000	52,300	57,500
Weight on trailing truck lb.	51,500	47,000	58,000	52,500	40,000	64,475	47,000	47,500	50,800	52,700	44,000	44,900	53,500	55,000	56,200	54,000	51,100	55,100
Weight of tender, loaded, lb.	160,500	173,400	161,000	183,000	161,500	184,495	161,500	155,200	142,700	168,800	147,600	152,700	158,000	166,600	217,300	159,800	154,700	202,300
Wheel base, driving, ft. & in.	18—0	16—6	16—9	18—0	16—6	13—0	14—0	14—0	13—8	13—0	13—0	12—8	13—10	13—0	13—8	13—0	13—0	13—8
Wheel base, total engine, ft. & in.	38—11	37—5	38—0	38—11	36—5	34—9	35—7	36—6	35—7	33—9	33—10	32—11	36—6	34—10	35—3	33—10	34—5	35—1
Wheel base, engine and tender, ft. & in.	70—2¼	70—6	71—4	76—8½	70—0	71—11½	68—2½	67—11	76—4⅜	66—9	64—3 11/16	64—5½	71—10	70—4¼	71—5¼	65—1¼	66—9¾	70—6¼
Diameter of drivers, in.	69	62	62	69	63	69	79	79	77	73	73	69	80	69	73	73	69	73
Cylinders, number	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	4
Cylinders, diameter, in.	28	29	28	27	28	27	27	23½	25	23½	23½	22	27	24	26	25½	25	17½ & 29
Cylinders, stroke, in.	28	28	32	28	28	28	28	26	28	30	28	28	28	28	26	28	30	28
Valve gear, type	Baker	Wals.	Wals.	Wals.	Baker	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Baker	Baker	Wals.	Baker
Steam pressure, lb.	185	180	180	190	170	185	185	200	215	210	180	190§	205	205	200	190	200	210
Boiler, type	Conical	Conical	Con. Bel.	E. W. T.	Conical	W. T.	Conical	Conical	Wootten	Str. Bel.	35—7	Straight	Belpaire	Straight	W. T.	W. T.	W. T.	W. T.
Boiler, smallest outside diameter, in.	78	83¾	82	76½	75¾	83 11/16	79	72	72¼	72	72	71	78½	78	80	76¾	78	70
Tubes, number and diameter in inches	207—2¼	243—2¼	283—2	193—2¼	218—2	244—2¼	207—2¼	175—2¼	234—2	155—2¼	205—2	141—2¼	237—2¼	252—2	244—2¼	195—2¼	211—2¼	199—2¼
Flues, number and diameter in inches	36—5½	40—5½	40—5½	34—5½	35—5⅜	43—5½	36—5½	32—5	32—5⅜	32—5½	28—5⅜	24—5½	40—5½	34—5⅜	40—5½	34—5½	38—5½	26—5½
Length of tubes and flues, ft. & in.	22—0	19—0	20—6	21—0	20—0	20—6	22—0	21—6	21—0	21—0	20—6	19—11	19—0	20—0	21—0	22—0	21—0	21—0
Heating surface, tubes and flues, sq. ft.	3,805	3,795	4,200	3,396	3,165.2	4,196	3,800	3,192.9	3,519	2,870	2,994.3	2,332	3,746	3,579	4,211	3,260	3,744	3,235
Heating surface, firebox, sq. ft.	312†	337	340	319†	285.5	282.8†	248	231.2	225	206	188	229.7†	288.6	317†	232	238†	238†	240†
Heating surface, total, sq. ft.	4,117	4,132	4,540	3,715	3,450.7	4,478.8	4,048	3,424.1	3,744	3,076	3,182.3	2,561.7	4,035.4	3,896	4,443	3,498	3,982	3,475
Heating surface, superheater, sq. ft.	944	845	1,075	865	761	991.0	897	765	812	640	691	615	1,153.9	796	980	805	955	619
Heating surface, equivalent,* sq. ft.	5,533	5,399.5	6,153	5,012	4,592.2	5,965.3	5,393.5	4,571.6	4,962	4,036	4,218.8	3,484.2	5,766.3	5,090	5,913	4,705.5	5,414	4,403.5
Grate area, sq. ft.	62.7	66.7	78	66.7	56.5	80.33	59.75	56.5	87	53.3	56.4	45	70	99.3	66.7	63.0	53.8	58
Firebox, length, in.	107 7/16	114⅛	117	114⅛	108⅛	120⅛	114⅛	108⅛	126⅛	116	108	90⅛	126	132⅛	114	108	108⅛	109⅝
Firebox, width, in.	84	84¼	96	84¼	75¼	96¼	75¼	75¼	104⅝	66¼	75¼	72¼	80	108¼	84¼	84	71¾	76¼
Kind of fuel	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Ant. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Ant. coal	Oil	Bit. coal	Bit. coal	Bit. coal
Tender, fuel capacity, tons or gallons	14	15	15	17	14	14	14	12	12	15	12	15	12½	14	3,300	14	14	12
Tender, water capacity, gal.	8,500	9,000	8,000	9,000	8,000	9,500	8,000	7,500	7,000	8,000	6,500	7,000	7,000	8,000	10,000	8,500	8,000	10,000
Weight on drivers ÷ tractive effort	4.48	4.13	3.52	4.40	4.14	4.12	4.24	5.55	3.89	3.51	4.75	4.35	4.81	4.79	4.20	4.33	3.84	4.86
Total weight ÷ tractive effort	6.66	5.69	5.27	6.60	5.87	6.72	6.59	8.70	6.30	6.17	7.51	7.34	7.38	7.20	7.05	6.98	6.09	8.16
Tractive effort × diam. drivers ÷ equivalent heating surface*	623.53	665.90	623.00	658.10	691.50	538.00	597.50	533.90	642.00	733.00	560.70	627.00	580.60	553.00	637.20	625.00	586.00	563.60
Equivalent heating surface* ÷ grate area	88.24	81.00	79.00	75.10	81.30	74.30	92.00	81.00	56.80	75.70	74.80	77.50	82.38	51.30	88.50	74.80	100.50	76.00
Firebox heating surface ÷ equivalent heating surface*, per cent.	3.35	6.24	5.50	6.37	6.23	4.74	4.60	5.05	4.54	5.10	4.46	6.59	5.05	5.45	3.93	4.04	3.70	5.45
Weight on drivers ÷ equiv. heat. surface*	40.50	44.20	35.40	42.10	45.30	32.30	32.00	37.50	32.60	35.30	36.50	39.60	34.90	37.60	29.20	37.10	32.60	37.50
Total weight ÷ equiv. heating surface*	60.18	61.20	53.00	63.20	64.50	52.30	49.90	58.80	52.80	62.00	57.70	66.50	53.70	57.70	48.90	59.75	51.80	63.00
Volume both cylinders	19.94	21.40	22.78	18.55	20.00	18.55	18.55	13.04	15.90	15.04	14.05	12.32	18.55	14.66	15.96	16.54	17.06	12.64
Equiv. heating surface* ÷ vol. cylinders	277.50	252.30	270.00	270.20	229.60	322.00	290.80	350.60	310.00	268.00	300.30	282.80	310.80	348.00	370.50	284.50	317.00	348.40
Grate area ÷ vol. cylinders	3.14	3.12	3.43	3.59	2.83	4.33	3.22	4.34	5.50	3.54	4.01	3.65	3.77	6.77	4.18	3.81	3.16	4.58
Reference to photographs, drawings or description	R.A.G.Jan. 1914-p86	Am.Engr. 1911-p381	R.A.G.Dec. 1914-p1047	....	R.A.G.M.E.‡ 1913-p585	R.A.G.M.E.‡ 1914-p614	Am.Engr. 1912-p5	Am.Engr. 1911-p133	R.A.G.M.E.‡ 1914-p117	R.A.G.Dec. 1914-p1050	....	....	R.A.G.M.E.‡ 1914-p347	R.A.G.Dec. 1914-p1188	....	R.A.G.Jan. 1914-p86	R.A.G.Nov. 1914-p1006	R.A.G.June 1914-p1519

* Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface. † Includes arch tube heating surface. ‡ *Railway Age Gazette, Mechanical Edition.* § Boiler designed for 200 lb.

EXAMPLES OF RECENT LOCOMOTIVES OF THE MIKADO TYPE

ARRANGED IN ORDER OF TOTAL WEIGHT

Type	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2	2-8-2
Name of road	P. & R.	L. S.	L. V.	E.P.&S.W.	Erie	N. P.	R. I.	P. R. R.	D.L.&W.	C.B.&Q.	C.&N.W.	L. & N.	B. & O.	A.T.&S.F.	Seaboard	S. P.	Maine Cent.	C.P.R.
Road number or class	1700	4008	306	367	3001	1743	2572	1752	1211	O-2	2301	2400	4317	3112	303	3270	601	5088
Builder	R. R. Co.	Amer.	Baldwin	Amer.	Baldwin	Amer.	Baldwin	R. R. Co.	Amer.	Baldwin	Amer.	R. R. Co.	Baldwin	Baldwin	Amer.	Baldwin	Amer.	Mont.Loc.
When built	1913	1913	1912	1914	1912	....	1913	1914	1912	1912	....	1914	....	1913	1914	1914	1914	1913
Tractive effort, lb.	57,319	56,050	58,100	59,900	52,460	57,200	57,000	57,850	57,000	60,000	55,300	57,000	54,477	50,700	50,200	51,000	51,200	42,000
Weight, total, lb.	331,000	322,000	321,800	321,000	320,600	320,000	319,300	319,300	312,000	303,400	302,000	302,000	284,500	284,100	282,000	280,960	275,000	258,000
Weight on drivers, lb.	249,000	245,000	232,300	242,000	237,150	240,500	238,200	238,850	236,500	231,000	227,500	236,000	222,000	218,900	207,500	214,020	213,500	198,000
Weight on leading truck, lb.	25,100	27,500	37,500	26,000	29,600	30,500	29,000	29,700	27,500	29,400	28,000	25,000	19,400	24,500	26,500	24,240	22,500	25,000
Weight on trailing truck, lb.	56,900	49,500	52,000	53,000	53,850	49,000	52,100	50,750	48,000	43,000	46,500	41,000	43,100	40,700	48,000	42,700	39,000	35,000
Weight of tender, loaded, lb.	160,000	155,800	153,200	174,000	162,400	193,900	160,700	158,000	159,700	176,600	165,500	169,500	175,500	170,900	183,000	170,040	156,000	170,000
Wheel base, driving, ft. & in.	16—6	16—6	16—6	16—6	16—6	16—6	17—0	17—0½	17—0	16—9	17—6	16—0	16—9	16—0	16—6	16—6	16—6	16—6
Wheel base, total engine, ft. & in.	36—0	36—1	35—2	35—3	35—0	35—3	35—2	36—4½	35—5	35—9	36—5	34—10	35—0	34—1	34—9	35—2	34—9	35—5
Wheel base, engine and tender, ft. & in.	68—4¼	68—10½	67—11½	68—4¾	66—10½	68—2¼	67—0½	72—3	67—7	67¾—0	68—11½	68—7½	71—2⅝	66—0¼	72—6½	69—9⅛	69—1½	66—5
Diameter of drivers, in.	61½	63	56	63	63	63	63	62	63	64	61	60	64	57	63	63	63	63
Cylinders, number	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Cylinders, diameter, in.	24	27	27	29	28	28	28	27	28	28	27	27	26	25	27	26	26½	23½
Cylinders, stroke, in.	32	20	30	30	32	30	30	30	30	32	32	30	32	32	30	28	30	32
Valve gear, type	Wals.	Wals.	Wals.	Baker	Baker	Wals.	Baker	Wals.	Wals.	Wals.	Baker	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.	Wals.
Steam pressure, lb.	225	190	175	176	170	180	180	205	180	180	170	185§	190	170	170	200	180	180
Boiler, type	Wootten	Straight	E. W. T.	Straight	Conical	Conical	Straight	Belpaire	Straight	Straight	Conical	E. W. T.	W. T.	W. T.	E. W. T.	Straight	E. W. T.	E. W. T.
Boiler, smallest outside diameter, in.	84	86	83¾	85¾	84	83⅝	86	78½	88	88½	81½	80	78	78¾	73 15/16	82	74	72
Tubes, number and diameter in inches	504—2¼	295—2	264—2¼	234—2¼	232—2¼	212—2¼	234—2¼	237—2¼	304—2	275—2¼	263—2	219—2¼	218—2¼	240—2¼	230—2	275—2	234—2	210—2¼
Flues, number and diameter in inches	.....	43—5⅜	43—5½	43—5½	36—5½	40—5½	36—5½	40—5½	43—5⅜	30—6	36—5⅜	40—5½	34—5½	36—5½	32—5⅜	36—5⅜	32—5⅜	30—5¼
Length of tubes and flues, ft. & in.	17—8	21—0	21—0	20—0	21—0	18—0	21—0	19—0	21—0	21—0	21—0	20—0	21—0	20—0	20—0	20—6	17—0	20—8½
Heating surface, tubes and flues, sq. ft.	5,210	4,494	4,547	3,975	3,936	3,266	4,017	3,746.8	4,592.8	4,373	3,939	3,680	3,710	3,849	3,290	3,973	2,832.2	3,410
Heating surface, firebox, sq. ft.	298	246	274	254.9	219	325	259†	288.6	261.3	254	259.6	263.29†	260	262	247†	242	273.3†	188
Heating surface, total, sq. ft.	5,508	4,730	4,821	4,229.7	4,155	3,591	4,276	4,035.4	4,859.1	4,627	4,198.6	3,943	3,970	4,111	3,537	4,215	3,105.5	3,598
Heating surface, superheater, sq. ft.	.....	1,065	1,101	1,030.1	1,050	846	900	1,153.9	1,065	961	890	922	838	880	759	890	636.4	760
Heating surface, equivalent,* sq. ft.	.....	6,327.5	6,472.5	5,259.8	5,730	4,860	5,626	5,766.3	6,456.6	6,068.5	5,533.6	5,326.29	5,227	5,431	4,675.5	5,550	4,060.1	4,738
Grate area, sq. ft.	108	59.6	100	70.3	70	70.4	63	70	63.1	78	63.1	58	70	58.5	63.2	70.4	56.5	50
Firebox, length, in.	144	114⅛	126⅛	120⅛	120	120⅛	108	126	108	117	116⅛	112¾	120	108	108	120⅝	108⅜	103¼
Firebox, width, in.	108	75¼	114¼	84¼	84	84¼	84	80	84¼	96	78¼	72¼	84	78	84¼	84	75¼	69⅞
Kind of fuel	Ant. coal	Bit. coal	Bit. & Ant.	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Bit coal	Bit. coal	Bit. coal	Bit. coal	Bit. coal	Oil	Bit. coal	Bit. coal
Tender, fuel capacity, tons or gallons	13	12	12½	15	16	16	16	12½	14	14	13	18	16	12	17	2,940	14	16
Tender, water capacity, gal.	8,000	7,500	8,000	9,000	9,000	10,000	9,000	7,000	8,000	9,200	8,275	8,500	9,500	8,500	9,000	9,000	8,000	8,402
Weight on drivers ÷ tractive effort	4.34	4.37	4.00	....	4.11	4.19	4.18	4.13	4.15	3.85	4.10	4.14	4.07	4.32	4.12	4.20	4.17	4.70
Total weight ÷ tractive effort	5.78	5.74	5.52	5.44	5.59	5.62	5.60	5.52	5.47	5.05	5.46	5.30	5.23	5.61	5.62	5.51	5.37	6.15
Tractive effort × diam. drivers ÷ equivalent heating surface*	640.0	558.0	502.6	717.4	631.8	741.5	638.3	621.9	556.1	632.7	609.6	642.1	667.1	532.1	676.4	578.9	794.5	558.5
Equivalent heating surface* ÷ grate area	51.0	106.3	64.7	74.9	81.9	69.0	89.4	82.4	102.3	77.9	87.8	91.9	74.6	92.8	74.1	78.9	71.8	94.7
Firebox heating surface ÷ equivalent heating surface*, per cent.	5.41	3.89	4.23	4.85	3.82	6.69	4.60	5.05	4.04	4.18	4.70	4.94	4.97	4.82	5.28	4.36	6.73	3.97
Weight on drivers ÷ equiv. heat. surface*	45.2	38.9	35.9	46.0	41.4	49.5	42.3	41.5	36.8	38.1	41.1	44.3	42.5	40.3	44.3	38.6	52.6	41.8
Total weight ÷ equiv. heating surface*	60.1	50.9	49.6	61.1	55.9	65.9	56.7	55.4	48.3	50.0	54.6	56.7	54.4	52.4	60.2	50.6	67.8	54.5
Volume both cylinders	16.8	19.9	19.9	22.9	22.8	21.4	21.4	19.9	21.4	22.7	21.2	19.9	19.7	18.3	19.9	17.2	19.2	16.1
Equiv. heating surface* ÷ vol. cylinders	329	319	326	230	252	227	264	290	302	268	261	268	265	297	235	323	212	294
Grate area ÷ vol. cylinders	6.45	3.00	5.03	3.07	3.08	3.29	2.95	3.52	2.94	3.44	2.98	2.92	3.56	3.19	3.18	4.09	2.94	3.11
Reference to photographs, drawings or description	R.A.G.M.E.‡ 1913-p411	Am.Engr. 1913-p235	....	....	Am.Engr. 1912-p87	....	R.A.G.Jan. 1914-p86	R.A.G.M.E.‡ 1914-p343	Am.E. 1912-p459	Am.Engr. 1912-p519	....	....	....	Am.Engr. 1913-p525	....	....	....	R.A.G.M.E.‡ 1914-p172

* Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface. ‡ *Railway Age Gazette, Mechanical Edition.* § Boiler designed for 200 lb. † Includes arch tube heating surface.

Characteristics Of Plate Springs

Part II*: Influence of Variables in Material and Construction Upon the Action of Springs; Design

By GEORGE S. CHILES

The experiments referred to in Part I had to do principally with springs which were all built or repaired in the same spring shop. It is advisable to consider briefly some of the variables effecting the construction of springs, it being reasonably evident that springs made in one shop may differ from those made in another shop, although the same specifications and drawings are followed in each case. Indeed, variations in workmanship may be found to exist in the same shop; two spring fitters working side by side and using the same grade of steel, may produce springs which give test results differing considerably from each other. This raises the question as to whether the test results from a number of springs may not vary to such an extent as to make impossible general conclusions relative to their actions in service.

In order to secure data which would settle this point and

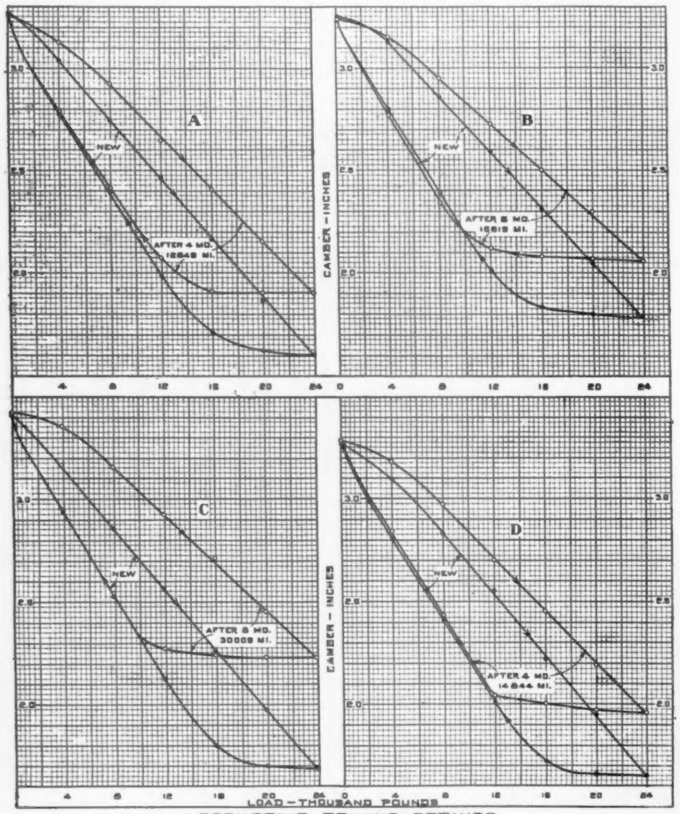


Fig. 12

determine the effect of po~~s~~sible variations in the quality of the steel, four similar springs were selected, each varying from the others either as to the place of manufacture or the source of the material used. These springs were applied to four Consolidation type freight locomotives of the same class, being located in each instance over the left No. 2 driver. After a few months' service, during which a record of the mileage was kept, the springs were removed and tested in the usual manner. The test curves are shown in Fig. 12. Spring *A* was built in a railway shop, the plates being painted with oil and graphite when assembled. Spring *C* was built in the same shop and assembled in the same manner but from steel rolled in a different mill. Spring *B* was built in a contract shop of the same material used in spring *A*. Although no data is available on this point it is assumed from a comparison of the curves taken when the springs were new that no lubricant was used betwen the plates of spring *B*. Spring *D* differs both in the point of manufacture

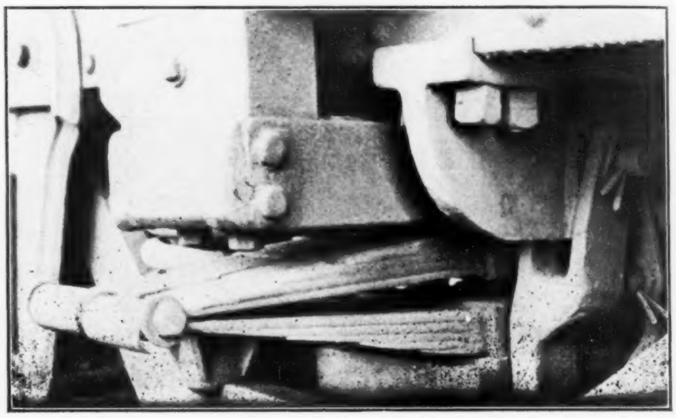


Fig. 13

and the source of material from all three of the springs previously mentioned.

It will be observed that the release load heights taken both before and after the springs had been in service approximate each other very closely. In contrast to the relative uniformity of these curves the heights for the applied loads differ considerably due to the stiffening effect of increased friction between the plates. It may therefore be concluded that variations in workmanship and differences in the source of material will have prac-

Fig. 14

tically no influence upon the future action of the springs as indicated by the release load curves of tests made at the time of manufacture.

The relation of the maximum fiber stress to which the material is subjected in service to the elastic limit of the material in the various plates has a large influence upon the future action of a spring. Both the fiber stress and the elastic limit of the

*Part I appeared on page 161 of the April, 1915 number and was concluded in the May, 1915 number, page 219.

material may vary at different sections of the same plate or in different plates.

While the maximum fiber stress is ordinarily the result of the load carried by the springs it may occasionally be considerably augmented, due to the condition of the track, passing over cross-overs, running onto turntables, etc. The possibility of this augmentation may be clearly brought out by considering the effect of entering a turntable, the ends of the rails on which are higher than the connecting track, upon the springs of a six-wheel switch engine. The forward pair of driving springs on an engine of this type is often suspended independently of the second and third pairs, and in passing onto the turntable these springs may receive a large additional deflection above that due to the static load, with a correspondingly increased fiber stress. The writer also calls to mind a consolidation type locomotive which was fitted with short driving springs having but little deflection when under load. The fiber stress of these springs based on the static load was much lower than that in the springs on other locomotives of similar design which were longer and more flexible. Notwithstanding their greater relative strength

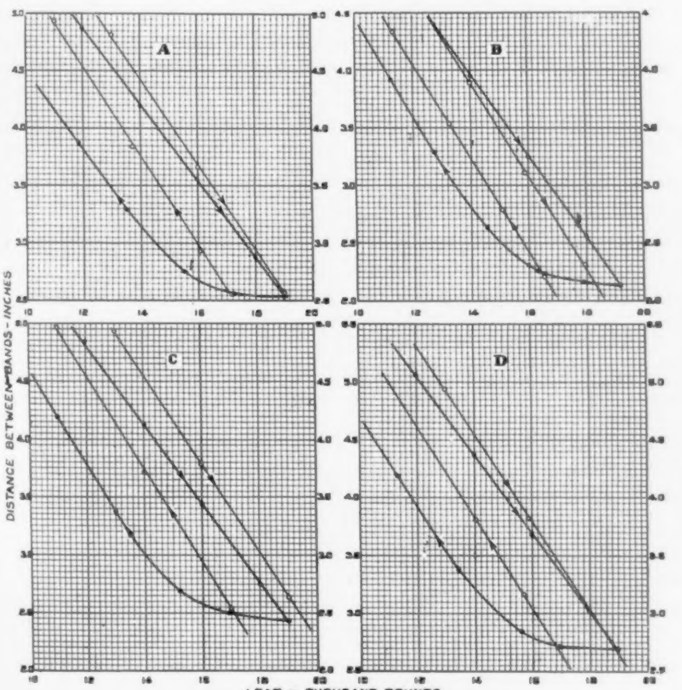


Fig. 15

the less flexible springs were productive of the greatest number of failures. In order to reduce the trouble more plates were added to the springs, the result being an increase rather than a decrease in the number of failures. Of course the strength of the springs was increased since the fiber stress under the static load was lower, but the decrease in flexibility resulted in increasing the fiber stress for any given deflection beyond that corresponding to the static load. What was really needed was more flexibility which might have been secured by increasing the length of the plates or decreasing their thickness. In this connection it may be said that a large portion of spring trouble is mainly due to lack of flexibility rather than to lack of strength. The degree of flexibility permissible depends on service conditions. For instance a passenger car bolster spring may be made too flexible for service on a branch line where, owing to the poor condition of the track and roadbed the car has a tendency to roll, although the same spring might be entirely suitable for service under main line conditions. For a locomotive the best results may be obtained with a less flexible spring under main line conditions than on the branch line. Excessive flexibility, however, may result in rolling and consequent hard riding of the locomotive on the branch line. It must be borne in mind in any case that the action of the spring is effected by the design of the locomotive and the service in which it is to operate, as well as the type of spring suspension, and these points must be taken into consideration in designing the spring.

Steel may be tempered to such an extent that it will be hard, although it does not appear brittle, and will soon break in service. The failures of plates made of such material usually necessitate the immediate removal and replacement of the springs, with an undesirable service delay. On the other hand the treatment of the plates may be such as to leave the steel soft, in which case the spring may give trouble, not by breaking but by the gradual settling of the plates, which is in reality the taking of a slight permanent set. This action does not attract attention as frequently as does the breaking of plates, because it is gradual and may be prolonged over a period of several months. Whenever settling takes place to any extent, at least, a part of the plates have undoubtedly been stressed beyond the elastic limit. Since the maximum fiber stress to which the steel is subjected in service is a varying quantity, it may at times readily exceed the elastic limit, in which case there is a resulting tendency to raise the elastic limit and, not considering fatigue, the tendency of the spring to settle may thus in time be overcome automatically.

It has been advocated that an elliptic spring be constructed so that when the bands come in contact the fiber stress is

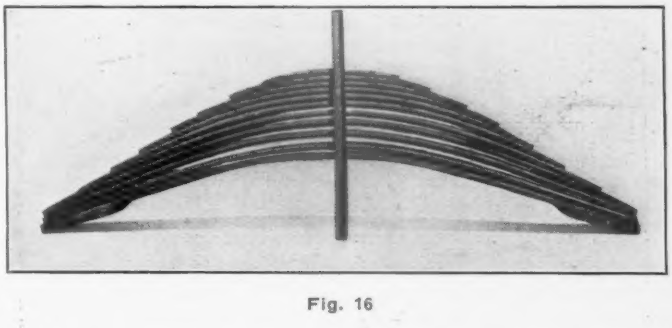


Fig. 16

below the elastic limit. Instances, however, have been observed where the distance between the bands is sufficient to allow a fiber stress 100 per cent or more in excess of that required to overstrain the steel, before the bands strike. These springs seem to give sufficiently satisfactory service, so that they are not removed, owing to the fact that they gradually settle in the manner outlined above without danger of bringing the bands in contact. While it may be desirable to so design springs as to make impossible excessively high stresses, carrying this practice too far may often necessitate the removal of springs because they have become solid much sooner than would have been the case had the distance between the bands been made greater.

The effect of the settling of springs differing in this respect is well illustrated in Figs. 13 and 14, both of which were taken from equipment in actual service. Fig. 13 shows a passenger car bolster spring and the amount it has settled may be seen from the distance between the top of the bolster and the truck frame. Fig. 14 shows a tender truck in which the bolster spring has settled until the bands are in contact.

The curves shown in Fig. 15 were taken from springs, the steel in which was evidently not tempered high enough for the service in which it was placed and shows the effect of subjecting material to a fiber stress in excess of its elastic limit. The springs from which these curves were plotted were in service under a passenger car seven and one-half months. They were assembled with oil and graphite between the plates and were

tested before being placed in service. A portion of the curves were plotted, the readings being indicated by the open circles. When removed from the car the springs were again tested, the readings being shown by the full circles. It will be seen that both the applied and release load curves obtained on the removal of the springs occupy positions considerably lower relative to those obtained from the new springs than do those shown in Fig. 12. With the exception of spring *B* the applied load curves taken after service are all below those taken before service, while instead of coinciding, the release load curves are widely separated. Otherwise the same general relation as to the relative slopes of the curves seem to hold, confirming the conclusion already indicated as to the effect of service upon the relation of the two sets of curves.

Whether springs are manufactured by hand or by the aid of the most improved machinery there is some difference of opinion as to the proper method of fitting the plates. It is generally the practice to bend each plate to a radius such that there will be "draw" or "tuck" between at least part of the plate when assembled for banding. The width of these openings varies and is often as great as 3/8 in. or 1/2 in. for the longer plates, decreasing as the plates become shorter. As shown in Fig. 16 a few of the shorter plates are fitted "dead" or without opening between them, especially in springs having a large number of plates.

When assembled in this manner it will be readily understood

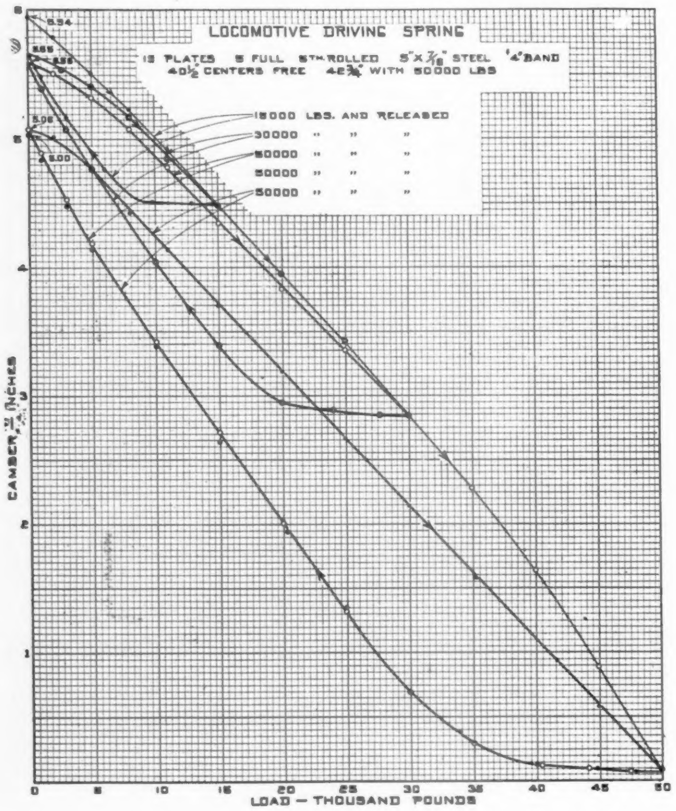


Fig. 17

that after being banded the curvature of each plate will have changed, the camber being different than it was before the band was applied. The camber of the longer plates is increased, while that of the shorter plates is decreased, the plates near the middle of the spring being the least disturbed.

In order to determine to what extent the different methods of fitting the plates would disturb the action of the spring a new 19-plate locomotive driving spring was fitted up in accordance with the practice just described, an unusually large amount of space being allowed between the longer plates in order to emphasize the effect and the shorter plates being fitted "dead." The total distance over the plates at the center of the spring was measured with the spring in three different positions, the weight of the plates and the method of support accounting for the different values obtained. The distance over the plates with the long plates down and the spring supported at the end was 12 1/4 in.; the distance with the long plates down and the spring supported at the center was 11 1/2 in.; with the long plates up and the spring supported at the center the distance was 12 3/8 in. The total thickness of the plates was 8 3/8 in., thus making the total opening for the three methods of measuring 3 7/8 in., 3 1/8 in. and 4 in., respectively. The camber of each plate was

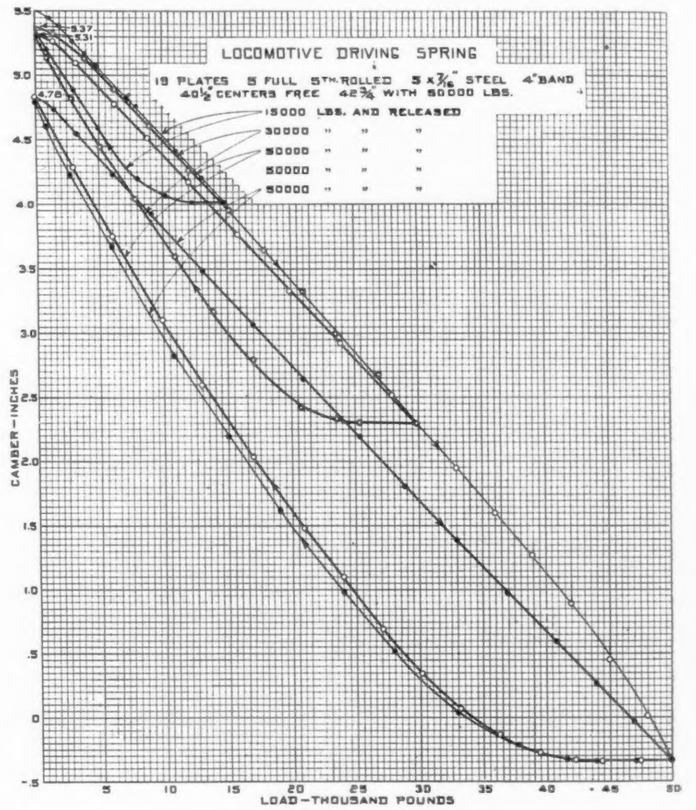


Fig. 18

recorded before the spring was banded. That of the main plate as tempered was 3.94 in., which was increased to 6 in. when the plates were brought together for banding, an increase of 2.06 in. On releasing the banding pressure it was found that the camber of the main plate was 4.05 in., an increase of .09 in. The plate was then jarred by holding it up and letting it fall, striking on its edge, but without decreasing the camber. This data secured, the spring was banded and tested. Contrary to the usual practice no preliminary load was applied to the spring, it being subjected to three successive loads of 15,000 lb., 30,000 lb. and 50,000 lb. respectively, with results as plotted in Fig. 17.

It will be noted that the camber of the spring after banding was 5.94 in., an increase in camber of 2 in. for the main plate. After the removal of the 15,000-lb. load the camber of the spring was 5.65 in., showing a decrease of approximately .3 in., which may be attributed to two causes: first, to the friction existing betwen the plates and second, to the straightening out of the shorter plates caused by the banding and loading. Both the banding of the spring and its load tend to straighten out the short plates, and it is possible that they may have been stressed to such an extent as to receive a permanent set. This would tend to reduce the camber of the spring as a whole. Attention is also called to the fact that the camber of the main plates under the 15,000-lb. load is approximately 4.5 in., which is still .56 in. greater than the original camber of this plate before banding.

The curve for the 30,000-lb. load passes through the maximum

load point of the preceding curve and returns to within .09 in. of its starting point, indicating a still further slight reduction in the camber of the spring. From the applied load curve it will be seen that when the load upon the spring amounted to 20,000 lb. the camber of the spring was equal to the original camber of the main plate before the application of the bands. It might be inferred that at this point the main plate was subjected to no stress. This is undoubtedly not true, however, since the camber of the plate was increased by taking a permanent upward set when the spring was banded.

Three applications of the 50,000-lb. load were made. The form of the first application curve beyond the maximum point of the 30,000-lb. curve indicates that the spring was taking a permanent set, and in order to obtain consistent results a second load was applied for which no values were recorded. The return of the release load curve to the initial point of the third application curve indicates that fairly constant conditions had been reached.

After this test was completed the spring band was machined off and the camber of the plates recorded. They were then reset and retempered, being fitted with a total opening between the plates of 7/8 in. before banding. This was the minimum space that it was possible to obtain with ordinary care in fitting, being so slight that the increase in camber due to banding was scarcely perceptible. The spring was then tested under the same conditions and with the same loads previously used, the results being plotted in Fig. 18. It was thought that with the

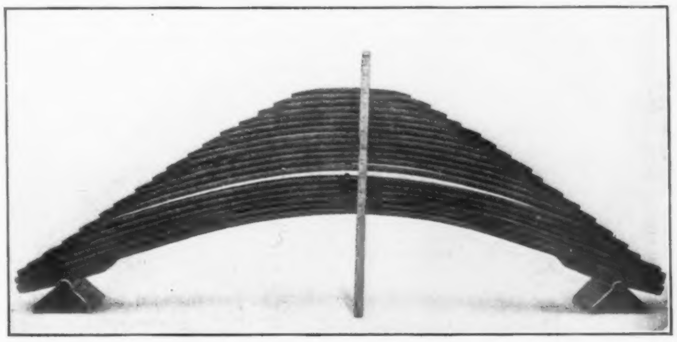


Fig. 19

plates fitted "dead" a spring would take a smaller permanent set than one fitted with considerable "draw" between the plates. The tests here recorded indicate that this is true up to a load of 30,000 lb., which is nearly 50 per cent greater than the load for which the spring was designed. The permanent set resulting from the 50,000-lb. load, however, shows practically no difference for the two experiments. The curves would seem to indicate that beyond a certain point the amount of permanent set taken by the spring is practically the same irrespective of the method of fitting the plates. It should be stated that the load of 50,000 lb. applied to the spring in this test is much greater than the spring will ordinarily be called upon to sustain in service.

Among shop men the opinion is generally held that springs built with openings between the plates are more flexible than those fitted with the plates "dead." This may be true to a certain extent for the reason that all of the plates are not uniformly stressed. Assuming, however, that such conditions exist at the outset, it is doubtful if an appreciable difference will exist after a few applications of an overload.

Upon the completion of the second test the spring band was machined off and the camber of the plates again observed. It was found that the relative position assumed by the plates after testing was practically the same in both cases, being as shown in Fig. 19, which was taken after the second test. It will be noted that while all the plates of the springs were in contact before the band was applied there is now considerable opening between the sixth and seventh plates. This division of the spring is due to the fact that the first six plates are full length and may therefore be considered as forming a beam of uniform section. The remaining plates, beginning with the seventh, are graduated and may be regarded as forming a beam of uniform strength. The load applied was great enough to give a permanent set to all of the plates, the load carried by each section under such conditions being proportional to the number of plates in that section. The deflection of the first six plates is therefore governed by the laws for a beam of uniform section, while the deflection for the remaining plates is governed by the laws for a beam of uniform strength, the deflection in the latter case being 50 per cent greater than that for the former.

From the foregoing consideration it may be generally concluded that variations in the fitting of the plates in springs similar in other respects will have little influence upon their flexibility in service. Even though the shop test is omitted the overloads received in service soon tend to eliminate any variations due to the method of fitting the plates.

[EDITOR'S NOTE.—The remainder of Part II will be published in an early issue.]

FORGED AND ROLLED STEEL PISTONS*

BY W. W. SCOTT, JR.†

So far as balance is concerned, the modern electric locomotive is almost perfect for there are no reciprocating parts to be partly or fully balanced. Hence the drawbar pull is practically constant, the weight on drivers is constant, there is no hammer blow on the rail and the locomotive is capable of much greater speed with safety than the most perfect reciprocating steam locomotive.

It is necessary, of course, to balance the reciprocating parts of a steam locomotive so that the engine will not buck or plunge and will have a fairly constant draw bar pull, but in the light of present-day knowledge, the old idea of using heavy reciprocating parts simply because they are strong and cheap, seems like putting the cart before the horse. It is evident without argument that the maximum weight on drivers should be figured for a higher speed than the locomotive makes on ordinary runs, because the static driver load in steam locomotives, unlike that in electric locomotives, is no indication whatever of the blow transmitted to the rail at speed, and has little to do with the effect on track, unless the static load is excessively high and causes a crushing of the rails due to rotating effect. The important fact is that the overbalance in the driver hammers the rail when the locomotive is in motion. The greater proportion of broken rails occur during freezing temperatures. Many of them are diagnosed as "crystallized." Let it be here stated that rails do not crystallize: such rails are broken by the centrifugal force of the overbalance coming at a time when the track is frozen rigid and cannot cushion the shock. To reduce the overbalance blow is to reduce the number of broken rails.

Would it not be wise to rule that no locomotive (let us say passenger at 70 m. p. h.; freight at 45 m. p. h.) shall have an impact on rail due to overbalance of more than 30 per cent of the static weight on the drivers? This is much better than the ordinary American practice, although it is strictly followed by the Pennsylvania Lines East of Pittsburgh whose maximum weight on one driving wheel is 32,500 lb. No engine is allowed to show more than 30 per cent dynamic augment (at the speed mentioned) or 9,750 lb. per wheel. That such a rule is not a hardship is proved by the fact that some of the German railways allow only 15 per cent dynamic augment at high speeds. When one considers the fact that in this country the average is about 62½ per cent, it is high time that it be reduced. A rule making necessary the reduction of reciprocating weights may, at first thought, seem to be a hardship, but a little reflection will show

*From a paper presented before the Railway Club of Pittsburgh, November 27, 1914.
†Carnegie Steel Company.

that to do otherwise, even though it adds a trifle to the first cost of the locomotive, is to be "penny wise and pound foolish." Let it be stated here, however, that a rolled and forged steel piston will not increase the cost of a locomotive. The value of all the reciprocating parts in all locomotives in this country probably does not exceed 1 per cent of the value of the rails in track, and it is positive economy to save the greater investment in rails by lightening the weights of reciprocating parts which represent the smaller investment.

A new method of manufacturing pistons has been developed by means of which a saving in weight of 10 to 50 per cent or possibly more for certain types, can be accomplished. The process has been worked out by the Carnegie Steel Company at its Homestead car wheel plant where, among other circular sections, pistons are made practically complete from the ore to the finished product.

The ingots are cast according to usual open hearth furnace practice in moulds 22 in. by 22 in. and about 6 to 7 ft. long. After stripping and soaking in the furnaces at the blooming mills in the customary way, the ingots are rolled into round blooms 15 in. in diameter and, while hot, sheared into discs or "cheeses" of the proper weight to produce the required section by further forging and rolling. Attention is called to the forging and rolling work done on the steel through the reduction of a 22 in. by 22 in. ingot into a 15 in. round in the blooming mill. This reduction represents a very important refinement of the rough cast ingot into a forged product of uniform and sound structure, which is far superior in its adaptability for the final forging operations than a raw casting of steel.

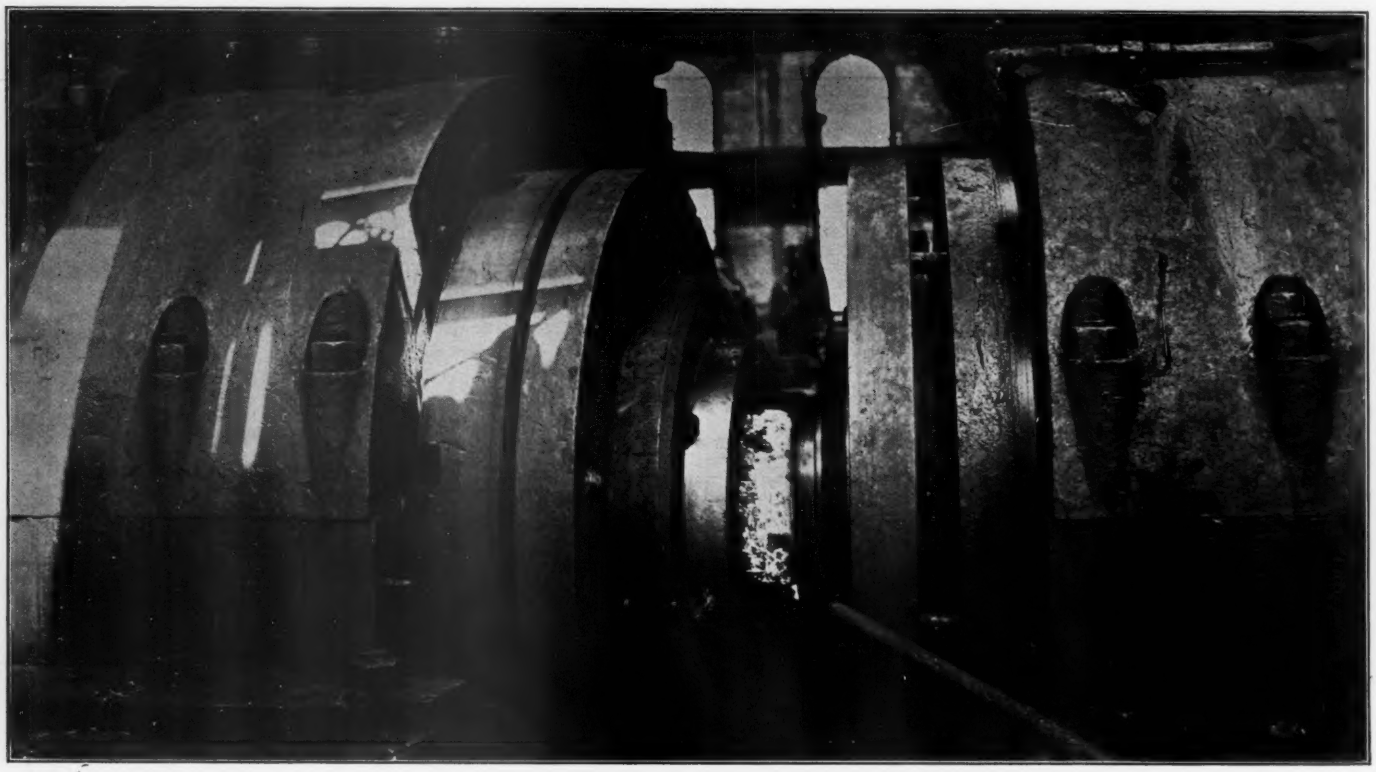
The question may arise as to why these blocks are sheared from rolled rounds into the form of discs rather than from flat slabs into the form of squares, as made for annular sections at Homestead and other plants some years ago.

The answer is the keystone of the present-day success of rolled steel sections such as passenger, tender and freight wheels, and lies in the fact that the outside of the ingot which, according to the nature of the elements composing it, is its best part, finally becomes by this process, the outside or periphery of the section while the center, naturally the weakest part, eventually becomes the core and goes back into scrap. It is, of course, understood that sufficient discard has been made from the rolled round bloom to insure freedom from piping.

The discs when cold are carefully inspected for surface or rolling defects and any present are either chipped out cleanly by means of pneumatic chippers, or the disc is scrapped. From the inspection yards the discs are taken to the wheel plants and in the case of pistons and other sections lighter than car wheels are heated in a continuous gravity furnace insuring the rolling of each disc in its proper order at a uniform heat.

By means of a dog running between two rails, each disc is transferred to a hydraulic press the function of which is to pierce a hole considerably smaller than the rough bore desired about half way through the center on the axis of the disc in order that it can be held between the rolls on a pin, until the hydraulic pressure applied grips it and forging commences. The mills were designed and patented by E. E. Slick and are unique in that they are the first of their kind ever built and are original in every respect. Each mill, of which there are two, is composed of two rolls or dies facing each other, set on the ends of two shafts which are out of line; one mill having the shafts approximately 14 deg. and the other approximately 7 deg. out of parallel. It is evident therefore that when the dies are brought together before the shafts turn, the disc is subject to a forging action. When sufficient forging has taken place under a hydraulic pressure starting at about 700,000 lb. and intensified to 3,000,000 lb. maximum at the finish in the larger mill, to start the piece into the contour of the die, power furnished by a 2,500-hp. steam engine is applied to revolve the roll shaft, and from this point until the piece is taken from the rolls, it is subject to both rolling and forging action, which insures close-grained, well-worked metal.

After rolling, the piece is put through a shear which automatically frees it of the "flash" which is usually present in a flat forging. In the same machine the core previously mentioned is punched out to make the rough bore, thus freeing the steel of any undesirable segregation that may happen to be present after



Forging and Rolling Mill in Which Pistons Are Formed

the discard from the round bloom has been made at the blooming mill shears.

After punching the bore, the piece is rough turned on the periphery, on the edges of the rim and on both faces of the hub in order that any scale or surface defects may be eliminated and clean, sound metal assured.

After passing final inspection, the product is ready for shipment. The method just described refers only to plate pistons.

Solid plate pistons are not new, steel castings in this form having been used as long ago as 1900 in Europe and are now used more or less extensively in this country in low pressure cylinders of compound engines where the diameters are such that the weight of a box or double wall piston would be prohibitive.

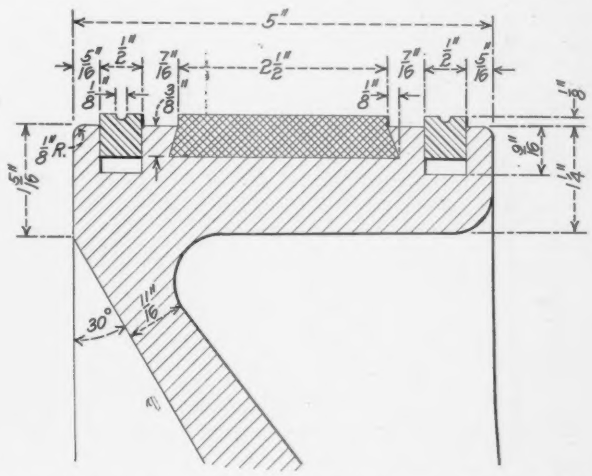
It is no doubt true that a steel piston working in a cast iron cylinder will score or cut the latter if they come in contact and with this contingency in mind, almost all American designing engineers bolt or rivet a cast iron bull ring to a steel center, the former being provided with grooves for cast iron piston rings. There have been some noteworthy diversions from this practice, however, particularly on locomotives operated by the Norfolk & Western Railway. One method used by this road is to pour molten iron into a groove machined in the face of the piston. Another is to pour in molten bronze in the same manner, afterwards turning in a lathe to the proper diameter. Both of these types are said to operate efficiently, but it is not the easiest task in the shop to replace the worn-down bearing surface, as the shrinkage of metals must be well understood by the workmen in order to get a tight fit. It is suggested here that the practice of designers of heavy stationary engines be followed in using solid rolled steel pistons in locomotives. That is to cut one or more dovetailed grooves in the face of the piston, insert segments of good malleable bearing metal and hammer it solidly into the grooves. It has been found that bearing metal in the face of the piston polishes the cylinder walls, thus facilitating lubrication.

Disc Sheared from Round Bloom; and Finished Piston

The solid steel pistons for the Pennsylvania Railroad are used with extended rods which have the advantage of reducing cylinder wear and simplifying lubrication. The extended rods in use some years ago, which were discarded, are not to be compared with those in use on the latest types of engines, for the old rods and pistons were much too heavy, the pressure on front bearings being as high as 50 lb. per sq. in., while the new type of extended rod has a pressure on the front bearing of only 10 lb. per sq. in. The old types of extended rods were of no particular value in saturated steam locomotives where good cylinder lubrication was comparatively easy to obtain. With superheated steam, however, a very different condition prevails as to cylinder lubrication, and it is the part of discretion to prepare for the contingency that when the engine is drifting long distances, the cylinders may not be properly lubricated.

If, then, there may be times under certain conditions when the cylinder is comparatively dry with the piston riding on the cylinder, it is certainly better practice to have an anti-friction metal in contact with the cylinder rather than even the best of cast iron, so that wear will be reduced to a minimum and scoring eliminated. For this reason it is recommended that solid steel pistons (unless supported by an extended rod) be faced with a bearing metal that will not only stand a temperature of 618 deg. F., but will also be malleable enough to permit of hammering in segments into dovetail grooves. We have made laboratory tests of a new bull ring metal which showed an extending point of 1,150 deg. F., an average scleroscope hardness of 8, and which can be easily peened into a dovetailed groove ¼ in. to ⅜ in. deep. This is not an experiment, for pistons as large as 50 in. in diameter, faced with bearing metal, are in use in many heavy duty rolling mill engines. Such a piston weighing 3,400 lb. may be found in operation at the Homestead steel works.

Time and test will prove whether the bearing metal mentioned will stand the ravages of superheated steam, but it is safe to assume that if it will not do, another bearing metal can be developed which will be satisfactory. We have known for many years that the proper kind of bearing metal will reduce friction,



Forged and Rolled Steel Piston Faced with Bearing Metal

and losses by friction in locomotive cylinders are more than a mere trifle.

It has been suggested that rolled and forged pistons be faced with a cast iron ring like piston rings except wider, set in a groove ⅛ in. less in depth than the thickness of the ring; the ring to be halved, or in three segments, and when assembled in the piston, to be slightly less in diameter than the cylinder. This scheme should work whether the bearing rings are fastened to the piston or simply held in place by the cylinder walls. It has a distinct advantage in the ease of replacement of the bearing face, as well as being economical.

Many ways can be worked out by which a forged and rolled steel center can be attached to cast iron bull rings, but if cylinder bushings or cylinders are to be protected against excessive wear, an anti-friction face is the logical progression. It is, of course, impossible to roll any kind other than one having a single plate. It is possible to roll centers that are intended to carry a cast iron bull ring, but the tendency of the times is to reduce the number of parts as well as the weight, and therefore the solid forged and rolled steel piston takes its place as the latest development in this line.

CRUDE OIL.—California's crude oil production in 1914 was 103,623,695 barrels, as compared with 97,867,147 barrels in 1913. —*Power.*

PERFORMANCE OF LOCOMOTIVE FIREMEN

W. J. Tollerton, general mechanical superintendent of the Rock Island Lines, in his testimony before the board of arbitration hearing the engineers' and firemen's demands for increased wages in the western territory, presented some very interesting testimony on the work performed by the firemen on different sizes of engines. He presented as an exhibit a summary of 1,556 tests of runs made in regular passenger and freight service on various roads, which showed that out of an average of 8 hr. 47 min. in total time on duty, the fireman was supplying coal to the firebox 1 hr. 42 min., or 19 per cent of the time. He was actually engaged in manual labor 2 hr. 42 min., or 31 per cent of the time, and for 6 hr. 5 min., or 69 per cent of the time, he was performing no physical labor. During these runs 8.67 tons of coal were used on an average per trip, which makes the average pounds of coal fired per hour during the whole time on duty 1,975 pounds. The total time on duty was computed from the time of departure to the time of relief from duty, and where it was the practice to allow preparatory or relief time, this was included. The times obtained for the actual supplying of coal to the firebox were taken by practical locomotive men on the roads making the tests by means of the stop-watch. This time includes not only the time actually spent in shoveling the coal into the firebox, but also the time consumed in leaving and returning to the seatbox or the gangway. In the same manner the time engaged in manual labor was obtained. This includes, in addition to supplying coal to the firebox, the sweeping of the deck, shaking the grates, taking coal and water, etc. The balance of the time, 6 hr. 5 min., or 69 per cent of the total time on duty, represents the time the fireman was either sitting on the seatbox or standing in the gangway at ease. In the majority of cases, the coal used was obtained by counting the number of scoops of coal supplied to the firebox during the individual trip.

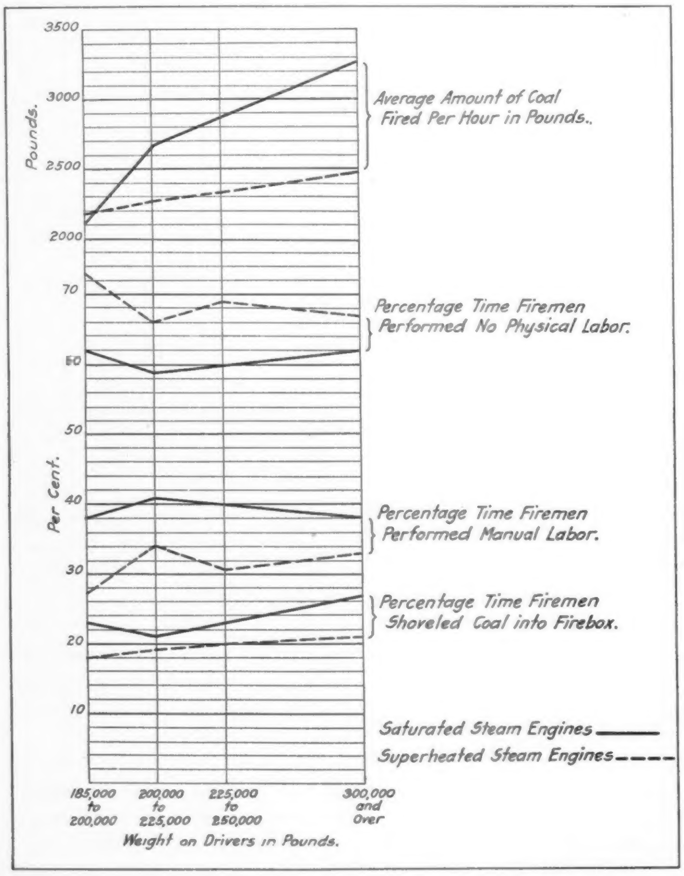


Diagram Illustrating the Performance of Locomotive Firemen

Mr. Tollerton also presented information from 474 trips made in freight service alone on locomotives weighing 185,000 lb. and over on drivers. The firemen on these test trips were on duty for an average of 9 hr. 39 min. They were supplying coal to the firebox 2 hr. 12 min., or 23 per cent of the time, and they were engaged in manual labor 3 hr. 14 min., or 33.5 per cent of the time, leaving 6 hr. 25 min., or 66.5 per cent of the time in performing no labor. The average amount of coal used per trip in this set of tests was 12 tons, making an average of 2,460 lb. per hour for the total time on duty. The information obtained from these tests was further subdivided between saturated and superheated steam engines for locomotives weighing from 185,000 lb. to 200,000 lb. on drivers; 200,000 to 225,000 lb. on drivers; 225,000 to 250,000 lb. on drivers and 300,000 lb. and over on drivers. The accompanying diagram illustrates the percentages of time the fireman was occupied in shoveling coal into the firebox, in performing manual labor, and in performing no physical labor, for the different classifications of the locomotive mentioned above. The curves at the top of the diagram show the average amount of coal fired per hour in pounds for the two classes of engines on a basis of the weight on drivers.

These diagrams show in an interesting manner the advantages to be derived from superheated locomotives and show conclusively that with the increase in the size of locomotives the rate of firing has increased very little. It is interesting to note also that the time the firemen spent in manual labor on heavy superheated steam engines does not amount to the corresponding time for even the lightest saturated steam engines shown. The results of these tests show how locomotive designers have, with the increased size in locomotives, considered the work of the fireman by providing labor-saving devices, such as superheaters, stokers, automatic firedoors, grate shakers and the like.

Technical High School in Milwaukee.—A plan for the establishment of an exclusively technical high school as part of the city of Milwaukee's educational system has been completed by Milton C. Potter, superintendent of schools, and Charles F. Perry, supervisor of industrial education. The board of school directors has taken steps looking to the immediate establishment of the institution. The academic work is to consist of a course in English, sciences and mathematics. Practical work is to be done in Milwaukee shops and factories.—*Iron Age.*

United States Navy Specifications.—The new specifications of the United States Navy indicate a changed opinion as to the extent to which sulphur is detrimental in steel castings. Former specifications allowed a maximum of 0.05 per cent sulphur in all carbon castings of grades A B and C and 0.04 per cent in nickel-steel castings designated as "special grade." In the new specifications grades A and B are subdivided into two classes—A and D, the high carbon, and B and E, the medium carbon respectively. A and B maintain the old limit of 0.05 per cent sulphur and D and E permit castings to go as high as 0.07 per cent sulphur. The two subclasses include castings of less importance than the others. For castings in grade C the limit is changed from 0.05 per cent sulphur to 0.07 per cent. The nickel-steel or special grade castings now have 0.05 per cent instead of 0.04 per cent sulphur as the limit. The requirements for tensile strength are reduced from a minimum of 90,000 lb. per sq. in. in nickel-steel to 85,000 lb. The elastic-limit stipulation is 45 per cent of the tensile strength in carbon castings, instead of a definite limit in pounds. The elongation requirements are advanced from 20 to 22 per cent in the special, or nickel-steel, grade, and the bending bar required is 120 deg. instead of 90 deg.—*American Machinist.*

CAR DEPARTMENT

FREIGHT CAR REPAIRS UNDER A PIECE WORK SYSTEM*

BY J. J. TOLIN

Foreman Car Repairers, Pennsylvania Railroad, Buffalo, N. Y.

Inspection of and repairs to freight cars on a shop repair track should be divided into three classes:

First—Light repairs to all classes, which should include the renewal of wheels, couplers, draft timbers, arch bars, and all repairs of a minor nature.

Second—Heavy repairs to all classes of wood or composite cars, which should include renewal or splicing of sills, renewal of roofs, or the complete rebuilding of the car body when necessary.

Third—Heavy repairs to all classes of steel cars, which should include the renewal or splicing of sills, renewal or patching of sheets, or the cutting down and rebuilding of the entire car when necessary.

Each of these classes should then be sub-divided into two classes: the air brake apparatus and its connections; and the other parts of the car. There should also be two sets of piece work inspectors and repairmen, one to act as specialists on the air brake apparatus and the other on the other parts of the car.

When a car requiring light repairs arrives on the repair track, the piece work inspector supervising repairs to parts other than the air brake should make a thorough examination of the wheels, journal boxes and their contained parts, arch bars, brake beams, and all parts below the body of the car. At the same time he should note the condition of the draft timbers, couplers, end sills, and all parts that are visible from the ground. He should then make the roof inspection, paying particular attention to the brake wheel, ratchet wheel and pawl, to see that the hand brake can be operated, and that the brake pawl will properly engage the teeth of the ratchet wheel. The deck hand-holds and running board also demand preferred attention since they are essential parts.

Next the interior of the car should be inspected, assuming that it is an empty house car, and repairs should be made according to the class of freight which the car is to carry. The authorized piece work card should then be prepared, enumerating thereon all defects which in the judgment of the piece work inspector should be repaired, and he should bear in mind that only such repairs as are necessary to make the car safe for trainmen and for lading suitable to it should be made to a foreign car. While making repairs, the repairman should be guided by the piece work card and should not be permitted to repair any defect that had been overlooked by the piece work inspector and discovered by him without first calling it to the attention of the piece work inspector and having it added to the work card if the inspector decides that the defect should be repaired.

The air brake piece work inspector should make a thorough inspection of the hose, hose couplings, pipe hangers, pipe supports, cylinder and reservoir and their blocks, to see that they are in good condition and firmly secured to the car. He should then fill out the authorized piece work form, noting thereon any defect that he may have discovered.

The car is now ready for the air brake repairman. He should first read the piece work card and then proceed to make the repairs enumerated thereon. When this has been done he should attach the yard air line to the air hose at one end of the car and a dummy coupling to the hose at the other end and open the valve from the yard air line. While the system is charging he should disconnect the retaining pipe from the triple valve and in the exhaust port of the triple place a nipple with an air gage attached to it. He should then take a pail of thin soap suds and with the aid of a suitable brush completely cover the air hose and all joints on the brake and crossover pipe. If a leak in either of these pipes is discovered the piece work inspector should be called and decide whether or not it is of enough importance to repair.

When the system is charged and the brakes are applied by making a 25 lb. reduction in brake pipe pressure, the length of the piston travel should be noted and the brake released by turning the air into the brake pipe through the 1/16 in. opening in the disk located in the ¼ in. pipe on the testing device. The gage which is attached to the exhaust port of the triple should be carefully watched for one minute and if it shows a leakage in excess of five pounds the defect causing the leak should be located and repaired. After the defect has been repaired a like test should be made to insure that the leak has been reduced below five pounds per minute.

The retaining pipe should be connected to the triple valve and slack adjusted if necessary, paying particular attention to the equalization of the brakes, and with the retaining valve handle at right angle on a two position valve or at 45 deg. on a three position valve, the brakes should again be applied and released. All joints on the retaining pipe should then be covered with soap suds and all leaks repaired, no matter how trifling they may be, for the reason that the retaining pipe must be absolutely tight, otherwise it is useless. The repairman should then wait until the air ceases to escape from the exhaust port in the retaining valve and then turn down the handle. If a gush of air escapes at this time the retainer is in good condition. If air escapes at a very low pressure or no air escapes the retainer is defective and should be repaired or replaced with a new or repaired valve. Under ordinary circumstances the brakes could now be depended upon as being in good condition.

HEAVY REPAIRS TO ALL WOOD OR COMPOSITE CARS

A wood or composite car requiring heavy repairs should be jacked up, placed on trestles and the trucks removed before inspection is made. The inspector should first thoroughly inspect the longitudinal sills, end sills, cross bearers, draft timbers, etc. Taking, for illustration, a box car, he should determine whether or not the general condition of the car would warrant putting it in condition to carry first class freight. If he decides that it should be made fit for this purpose he should inspect the siding, lining, flooring and grain strips, condemning any of these parts that are not in perfect condition. The roof should then be thoroughly examined for evidence of leaks and if any are found the cause must be remedied.

All parts of the trucks should now be examined and the piece-work form prepared, which should show all repairs necessary, except to the air brake apparatus.

While the car is undergoing repairs the work should be closely checked by the piece work inspector to see that both lumber and bolts of proper dimensions are used; that the lumber is properly framed, and that holes bored by the repairmen are not more than 1/16 in. larger than the diameter of the bolts or rods that are to be placed in them. The piece work inspector should also see that all parts are applied as shown on the standard drawing, that is, the sizes of tenons, mortices, etc., not changed by the repairmen to make the part simpler to apply.

The air brake attention in this case is much the same as in that of the car requiring light repairs with the exception of removing and replacing the apparatus, including pipe where it

*From a paper read before the Niagara Frontier Car Men's Association, Buffalo, N. Y., June 16, 1915.

interferes with the renewal of longitudinal sills. It is also important in this case that pipe be thoroughly blown out before it is connected to the triple valve. The brake apparatus must be cared for while it is off the car by closing the opening in the triple valve check case and exhaust port with wooden plugs to prevent dust from entering the triple.

HEAVY REPAIRS TO STEEL CARS

The all-steel car does not ordinarily require heavy repairs as frequently as the car of wood construction, but when it does require this class of repairs they are usually more extensive; consequently the number of days out of service per year is approximately the same as that of the wooden car.

The time out of service can be reduced, however, by increasing the number of men working on the car, and in order to do this and still maintain a high degree of efficiency the men must specialize on some particular kind of work; for instance, cutting off rivets, heating rivets, driving rivets, etc.

My slight experience in the steel car field has taught me that as many as fifteen repairmen can be successfully worked on one car, as follows: Cutting off and backing out rivets, four; repairing bent parts off car, bolting them up in place for the riveters and straightening parts on car, four; reaming and drilling holes, two; heating rivets, one; driving rivets, two; removing and replacing parts that are secured with bolts and repairing trucks, two. It is, of course, understood that for this arrangement to be practical there must be several cars on the repair track at one time.

Like the wooden car the steel car should be jacked up, placed on suitable trestles and the trucks removed. All parts that have been affected by corrosion should have the scale removed. The car should then be carefully gone over by the piece-work inspector, he to decide what repairs are to be made and at the same time see to it that no part or parts are removed from the car for repairs that can be successfully repaired in place by using a portable oil heater. He must also exercise good judgment in condemning sheets to be scrapped, particularly in the floors, where it is practicable that floor sheets should be patched until an entire new floor is to be applied. When a floor is to be renewed and one or more sheets are found in fairly good condition, they should also be removed and replaced with new sheets and the sheets that are in fairly good condition placed in stock for repairs to floors that are not yet at a point where the entire floor requires renewal.

The splicing of steel longitudinal sills while in place is very economical. For illustration, in the case of a steel car that has been in an accident and has the longitudinal sills so badly buckled at one or both ends that they cannot be straightened while in place, the sills should not be removed for repairs, but the damaged ends should be sawed off, repaired and spliced to the sills. This can be done at a cost much below that of removing the full length sills for repairs, and the result obtained is just as good or better.

The manner in which rivets are driven in steel cars is another important feature. The piece work inspector should inspect each morning all rivets driven by the repairmen on the day previous, and each rivet should be tapped with a light hammer, and any found loose ordered removed. Rivets with heads poorly formed on account of poor heating, or rivets too long or too short should also be ordered removed and only the rivets that pass inspection should be paid for. The number of rivets driven should be checked daily by the piece work inspector for the reason that some of them may become covered with other parts and could not be checked at a later date. The rivets that have been checked can easily be identified if bright red paint is used to mark them as they are counted.

The air brake attention necessary is practically the same as in the case of light repairs, except that care should be exercised to keep the cylinder, triple valve, etc., from coming in contact with excessive heat when straightening parts in place.

FORTY-TWO YEARS AGO

In a talk before the Master Car Builders' Association during the convention held in Boston in June, 1873, Leander Garey of the New York Central presented some statistics as to the number of cars in service at that time. Compared with the two million odd cars, most of them of large capacity, now owned by the railroads of this country they present an interesting view of the growth and changes in conditions of railroad transportation which have taken place during the past 42 years.

The following is quoted from Mr. Garey's remarks:

"The whole number of cars on all steam roads of 4 ft. 8 in. and wider gages in the United States and Canada, at the close of the fiscal year ending with the year 1871, was as follows:

Whole number of 8-wheel cars	193,767
Whole number of 4-wheel cars	58,355
Total	252,122
Whole number of cars reported for 3 and 3½-ft. gage roads	212

There are in the United States and Canada 103 car manufacturing companies. These companies have built during the year ending May 31, 1873, the following number of cars:

PASSENGER CARS

Palace, sleeping and hotel cars	134	Baggage and mail cars	33
Passenger cars, all classes	579	Baggage cars	63
Smoking cars	18	United States postal cars	3
Baggage and smoking cars	15		
Baggage and express cars	18	Total	863

OTHER CARS

Paymaster cars	6	Stock cars	2,415
Caboose cars	78	Eight-wheel ore and coal cars	3,126
Fruit cars	734	Four-wheel ore and coal cars	3,226
Refrigerator cars	8	Oil tank (60 barrels)	250
Grain combination	750	Oil tank (64 barrels)	300
Box or house-cars	11,931	Construction cars	162
Platform	5,694	Steam shovels	52
Gondola	6,733	Derrick cars	8
Double-bottom gondola	125	Hand cars	149
Double-deck cars	80		
Hay (box)	75	Total	36,765

[A similar statement was made of the cars built by the railroads. Because of space limitations it is omitted, but the total number was 22,345 standard gage cars and 466 narrow gage cars. —EDITOR.]

Mr. Garey then continued:

"Allowing six months for the time between the close of the fiscal year of 1871 and the first of June, 1872, we will add one-half of the number of cars constructed during the past year to the number officially reported at that time (1871), and we have for number of cars on the first of June, 1872, 281,667. Add to this the number manufactured during the past year, and it gives us for the total number of cars at the present time, 340,787.

"The increase of cars here stated is under the actual number, as a few roads have failed to report.

"These figures indicate that the increase of cars during the past year has been about 25 per cent, and if we add the cars rebuilt, it will make the increase fully that number."

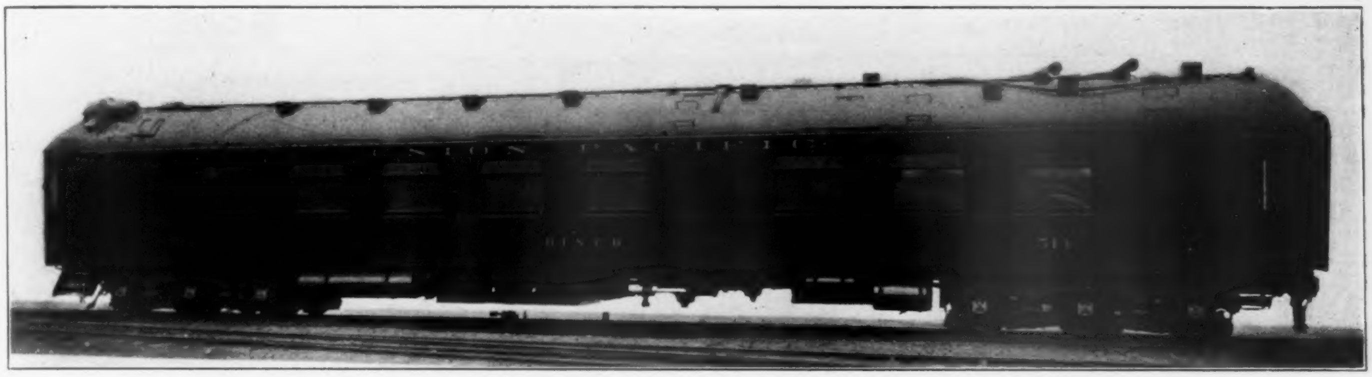
THE IRON CROSS.—The iron cross, the most highly-prized recognition of valor in the German army and navy, is not a casting, but is struck with steel dies in heavy coining presses. After being stamped out, the crosses are taken to the silversmith's, where the soldering is done, a fine silver border added, and the finishing completed. The silver border is polished on electrically-driven polishing and grinding motors.—*The Engineer.*

PRESSURE DROP AND VOLTAGE DROP COMPARED.—Pressure drop in steam lines is comparable with line drop in electric distribution systems, which is known to be energy lost, but the desired terminal voltage is obtained and the drop compensated for by a slight increase of voltage at the source or apparatus designed to use the lower voltage. Feeders or steam lines large enough to cause no drop are not feasible; the amount of drop to be permitted is a variable quantity. The greater radiation loss from excessively large steam lines has no counterpart in the electric-distribution analogy.—*Power.*

STEEL CARS OF THE ARCH ROOF TYPE

Features of Latest Union Pacific Equipment for Various Classes of Passenger Train Service

The Union Pacific has recently added to its equipment a number of all-steel passenger train cars, built by the Pullman Company. These include dining cars, combination baggage-buffet cars, chair cars, coaches, baggage cars and postal cars.

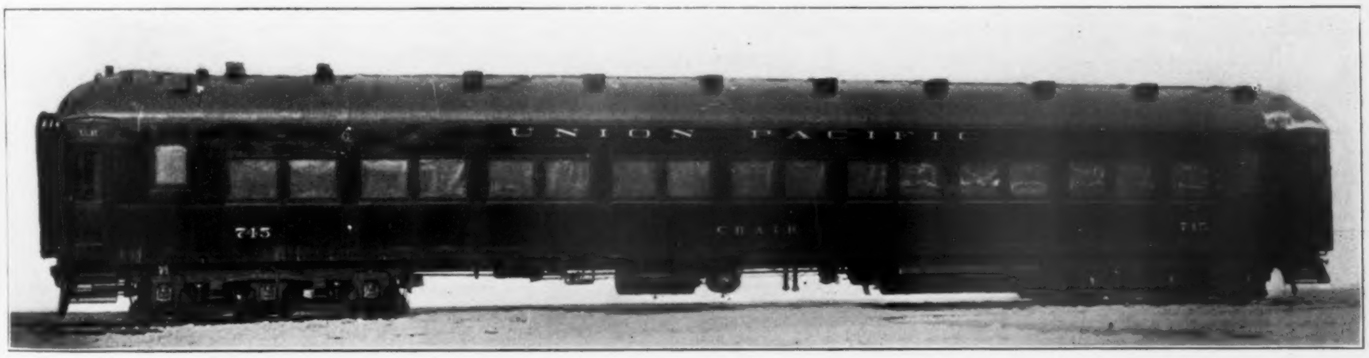


Steel Dining Car in Service on the Union Pacific

The dining cars are 72 ft. 6 in. long over the end sills and 80 ft. 5 in. long over the platforms. The wheel base is 67 ft. 9½ in. and they are mounted on six-wheel trucks. These dining cars have a seating capacity of 30 passengers and weigh about 148,000 lb.

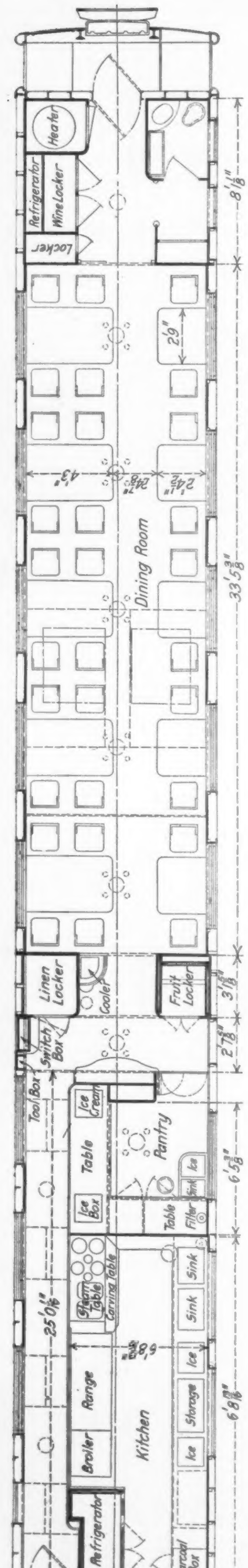
The combination baggage and buffet cars are 75 ft. long over the end sills and are mounted on six-wheel trucks, the total wheel base of the car being 67 ft. 9½ in. The seating capacity is 28 and the weight of the car ready for service is about 139,000 lb.

The same design of body is used on the coaches and the chair cars, the length over the end sills being 70 ft., the length over platforms 77 ft. 11 in. and the wheel base 65 ft. 3½ in. These cars are also mounted on six-wheel trucks and weigh about 138,000 lb. Some of them are equipped with a smoking room in one end, in which case the seating capacity of the chair cars is 70, while without the smoking room it is 72; when equipped with a smoking room the coaches have a

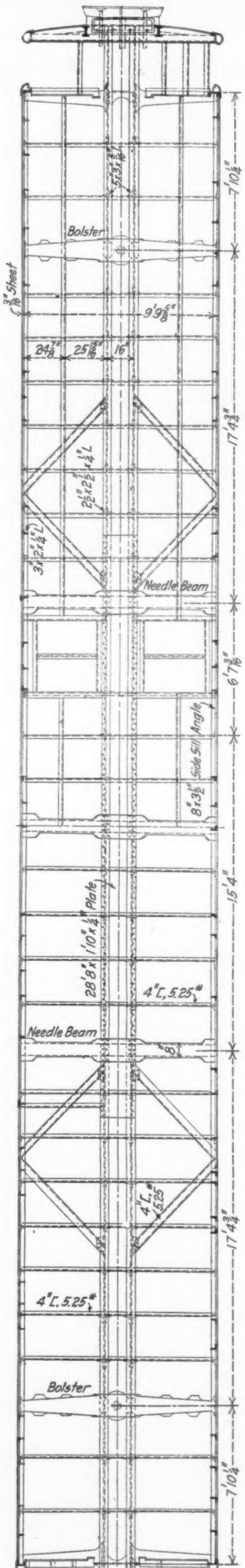


Reclining Chair Car of All-Steel Construction, Used on the Union Pacific

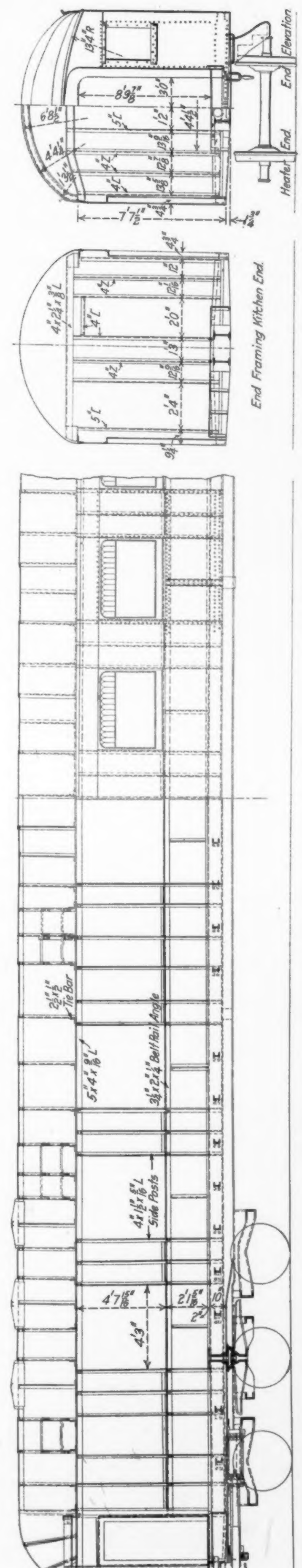
Union Pacific All-Steel Postal Car



Floor Plan of the Union Pacific Dining Car



Arrangement of the Underframe of the Union Pacific Dining Car



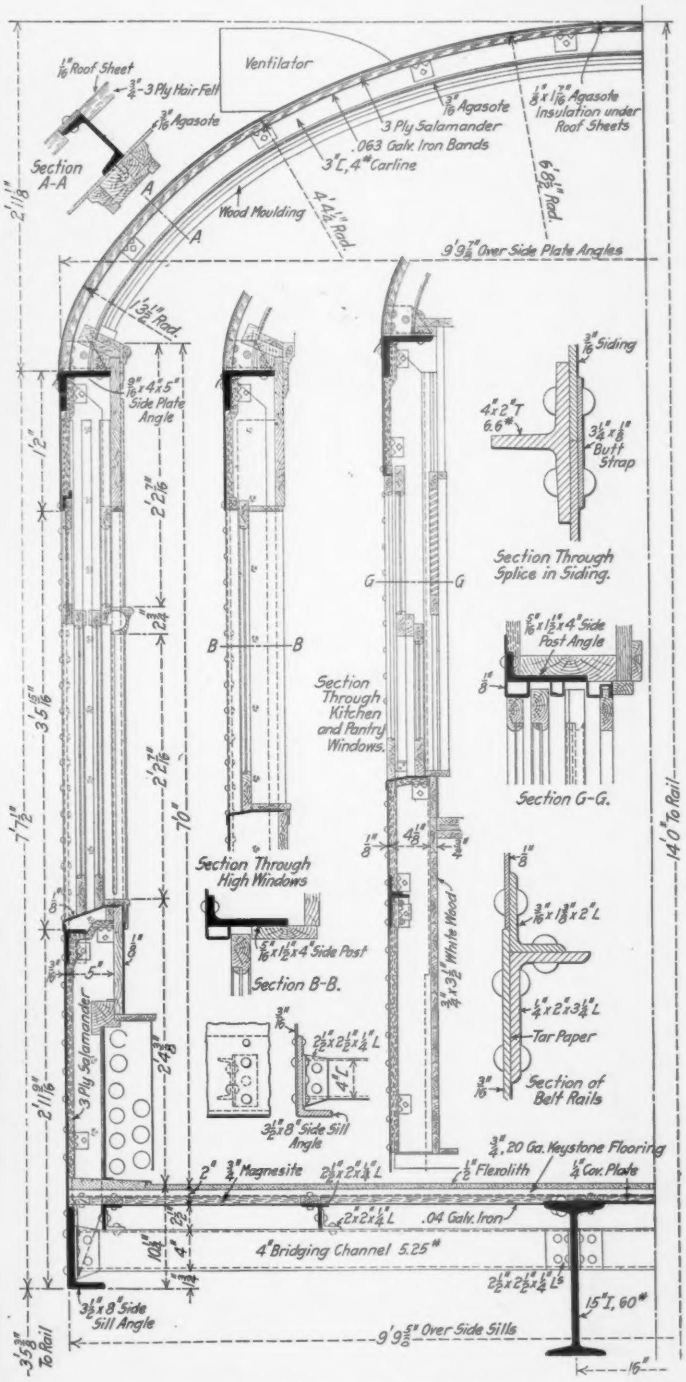
Elevations and Sections Showing the Body Framing, Union Pacific Dining Car

An Interior View of the Dining Car

An Interior View of the Baggage-Buffet Car

seating capacity of 82 and this is changed to 84 in the case of a car without a smoking room.

The baggage cars are 69 ft. 0-7/8 in. long over end sills, 71 ft. 11 in. long over the platforms and have a wheel base of 64 ft. 0-7/8 in. They are mounted on four-wheel trucks and weigh about 106,000 lb. The postal cars are 60 ft. 1½ in. long over end sills and 63 ft. long over the platforms, with a wheel base of 55 ft. 1½ in. These cars weigh 111,600 lb. There



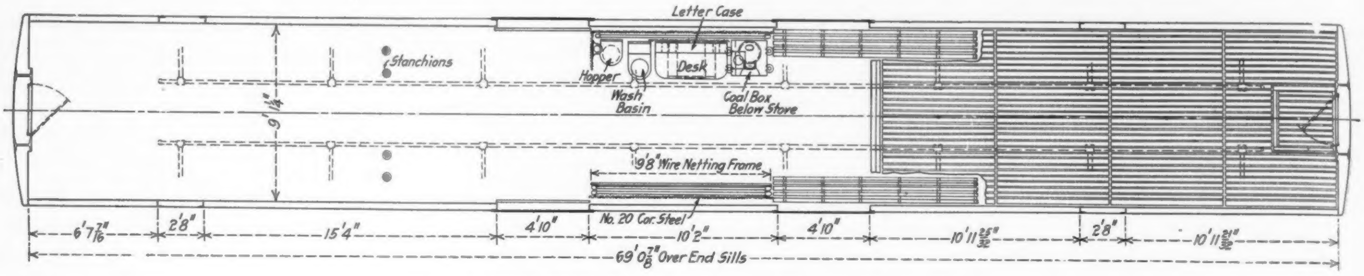
Cross Sections of the Dining Car

are also a number of 60-ft. baggage cars similar to these postal cars. Where six-wheel trucks are used, the design is the same for all the cars and the same is true for the four-wheel trucks.

As will be noted from the illustrations, the type of construction embodies the arch type roof and the arrangement of the framing is similar in all of the cars. Ventilation is

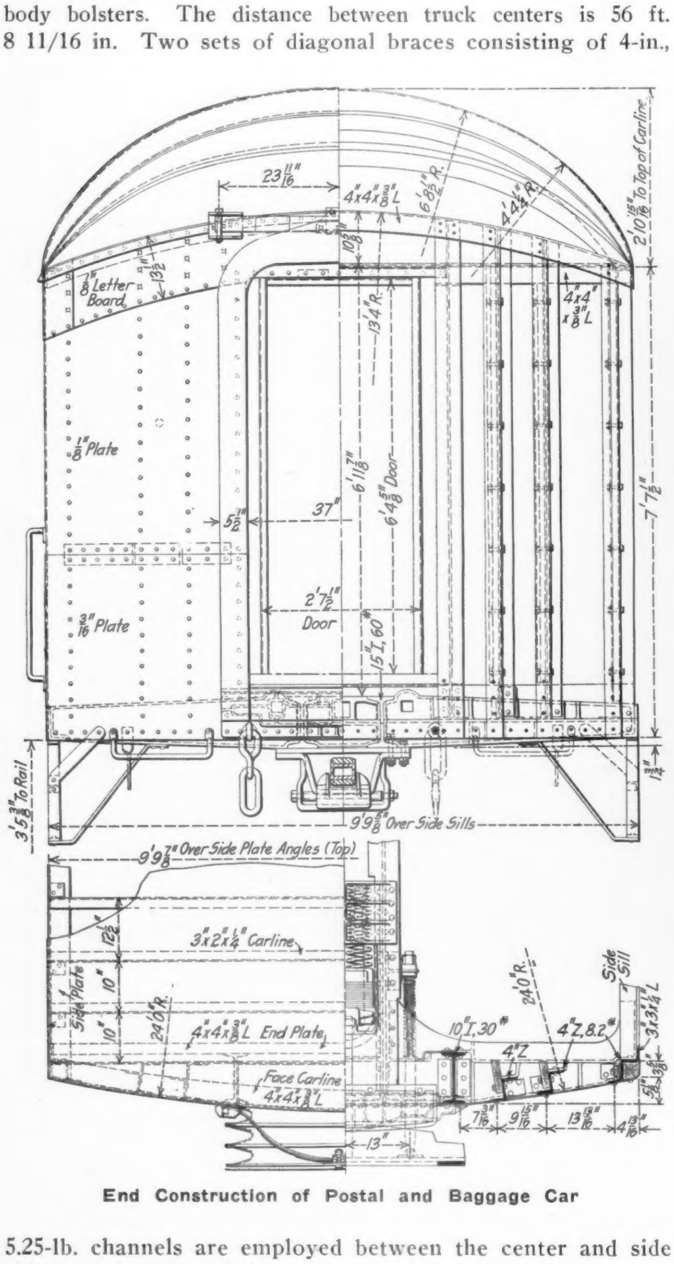
provided by suction type ventilators and has proved to be adequate in all cases.

In the dining car, the center sills consist of two 15-in., 60-lb. I-beams placed at 16-in. centers and extending between the platform end sills. A 22-in. by 1/4-in. top cover plate is used



Floor Plan of Steel Baggage Car for the Union Pacific

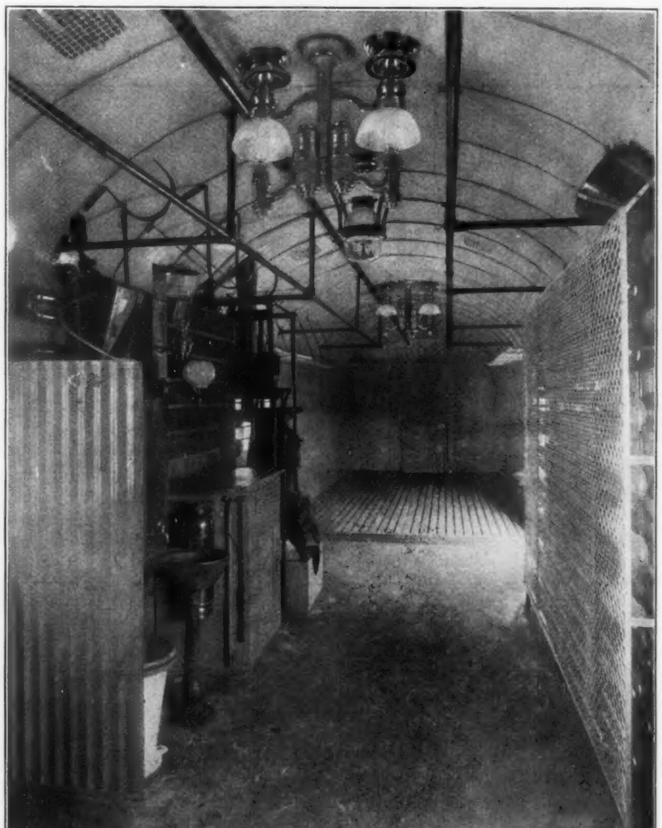
and the sills are given 3/8-in. camber. The body bolsters are steel castings and there are three crossbearers between the body bolsters. The distance between truck centers is 56 ft. 8 11/16 in. Two sets of diagonal braces consisting of 4-in.,



End Construction of Postal and Baggage Car

5.25-lb. channels are employed between the center and side sills and channels of the same size and weight are also used to support the floor stringers, which are 2 1/2-in. by 2-in. by 1/4-in. angles. The side sills are 3 1/2-in. by 8-in. angles, a 3/16-in. plate being riveted to the side sill and to the belt rail, which is a 1/4-in. by 2-in. by 3/4-in. angle with the 2-in. leg upward, to which is riveted a 3/16-in. by 1 3/8-in by 2-in. angle. The 3/16-in. steel sheathing extends to a point just above the connection between the two belt rail angles, and 1/8-in. sheathing is used on the car body above this point.

The body side posts are 4-in. by 1 1/2-in. by 5/16-in. angles and the side plate is a 5-in. by 4-in. by 9/16-in. angle. The carlines are 3-in., 4-lb. channels extending through between the side plates, and the end plate is a 4-in. by 2 1/4-in. by 3/8-in. angle. The body corner posts are 4-in., 5.25-lb. channels and the door posts are 5-in., 6.5-lb. channels, there being two intermediate posts consisting of 4-in., 13.8-lb. Z-bars. The



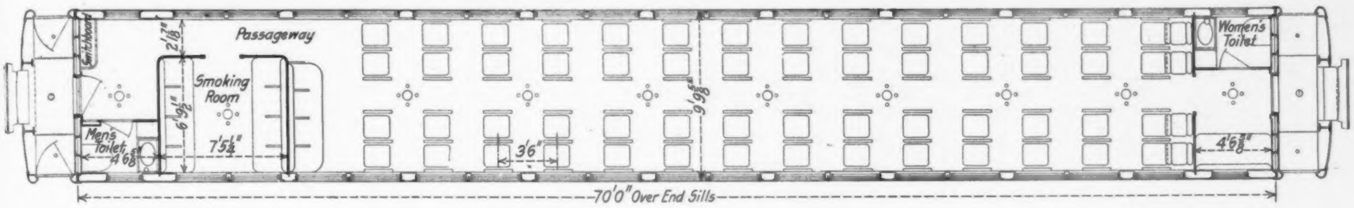
Interior of Union Pacific Steel Baggage Car

vestibule door posts are 6-in., 23.9-lb. I-beams, braced at the top to the body corner posts by 3-in. by 3-in. by 1/4-in. angles, while a 6-in., 8-lb. channel forms the vestibule end plate. The end sheathing of the car body is 1/8 in. thick.

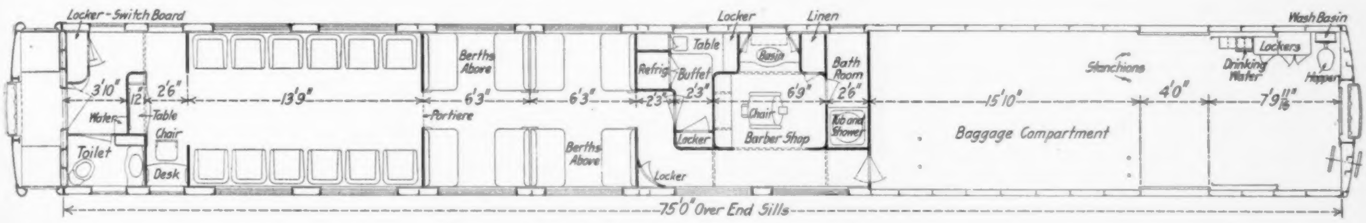
Above the floor stringers is placed .04-in. galvanized iron, above which there is a layer of 3/4-in. Magnesite. Next to this is a layer of 3/4-in., No. 20 gage Keystone flooring, above which is placed the final flooring, which is 1/2-in. Flexolith. Three-ply Salamander insulation is applied to the inside of the steel sheathing, and the windows as well as the interior

finish of the side walls are mahogany; the headlining is 3/16-in. Agasote. The baggage-buffet cars also have mahogany interior finish, but that of the chair cars and coaches is steel. The I-beam center sill construction is used in all of the cars. In the case of the coaches and chair cars these sills are 18-in., 65-lb. I-beams with a 1/4-in. cover plate, while the side sills are 8-in. by 3 1/2-in. angles, the floor being carried by 4-in., 5.25-lb. channels supporting 2-in. by 2 1/2-in. by 1/4-in. longitudinal floor stringer angles. The belt rail is a 3 1/4-in. by 2-in. by 1/4-in. angle, while the side plate is a 5-in. by 4-in. by 9/16-in. angle. The carlines are formed of 3-in., 4-lb. channels. The window sash in these cars are of wood, while the main part of the interior finish is of steel and the headlining is 3/16-in. Agasote.

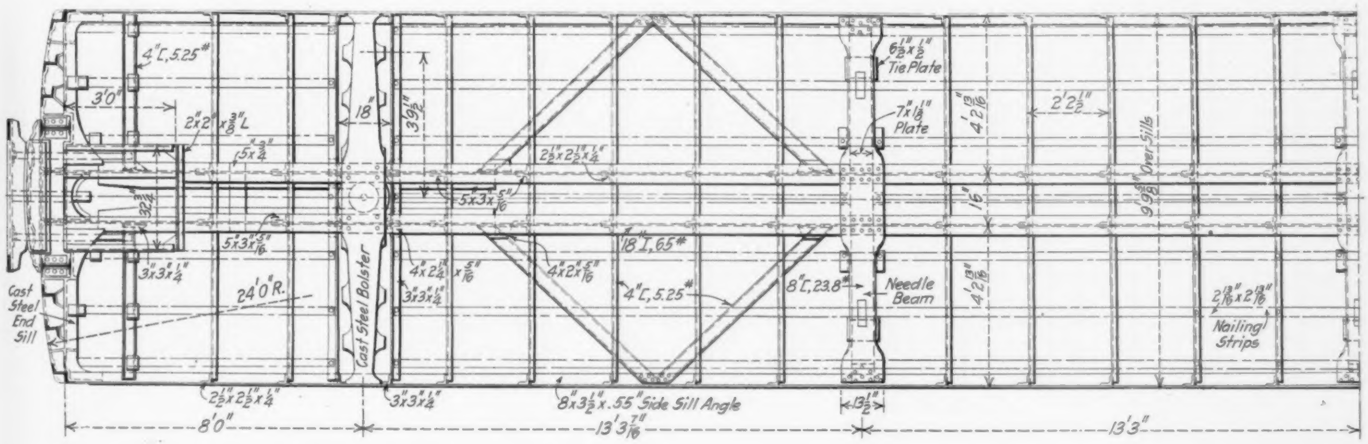
The center sills of the 69-ft. baggage cars are 18-in., 65-lb. I-beams and the side sills are 8-in. by 3 1/2-in. angles. The

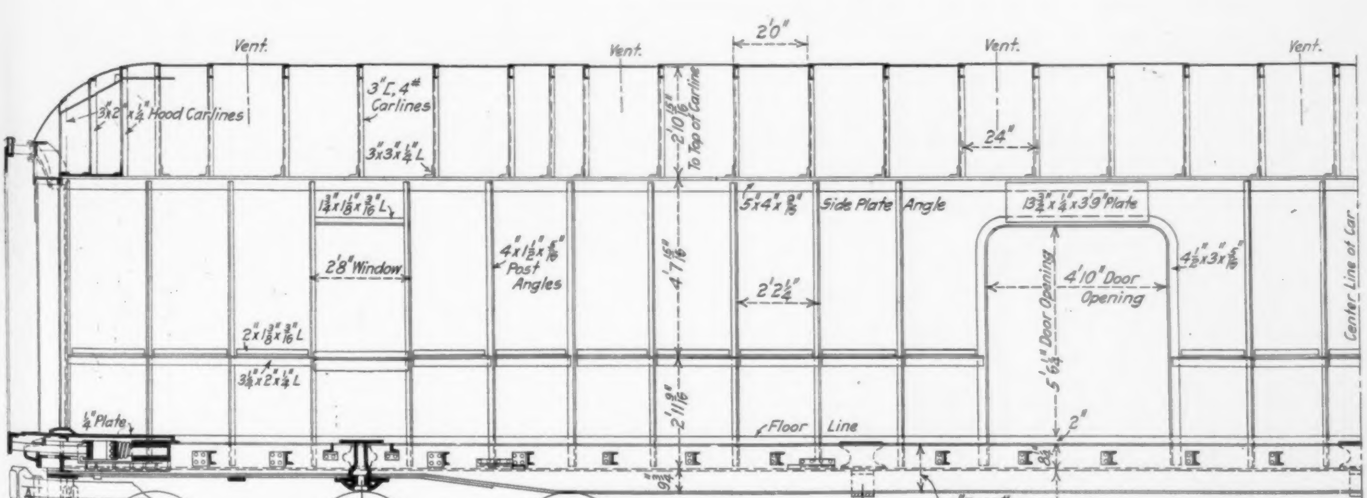


Floor Plan of Union Pacific Chair Car

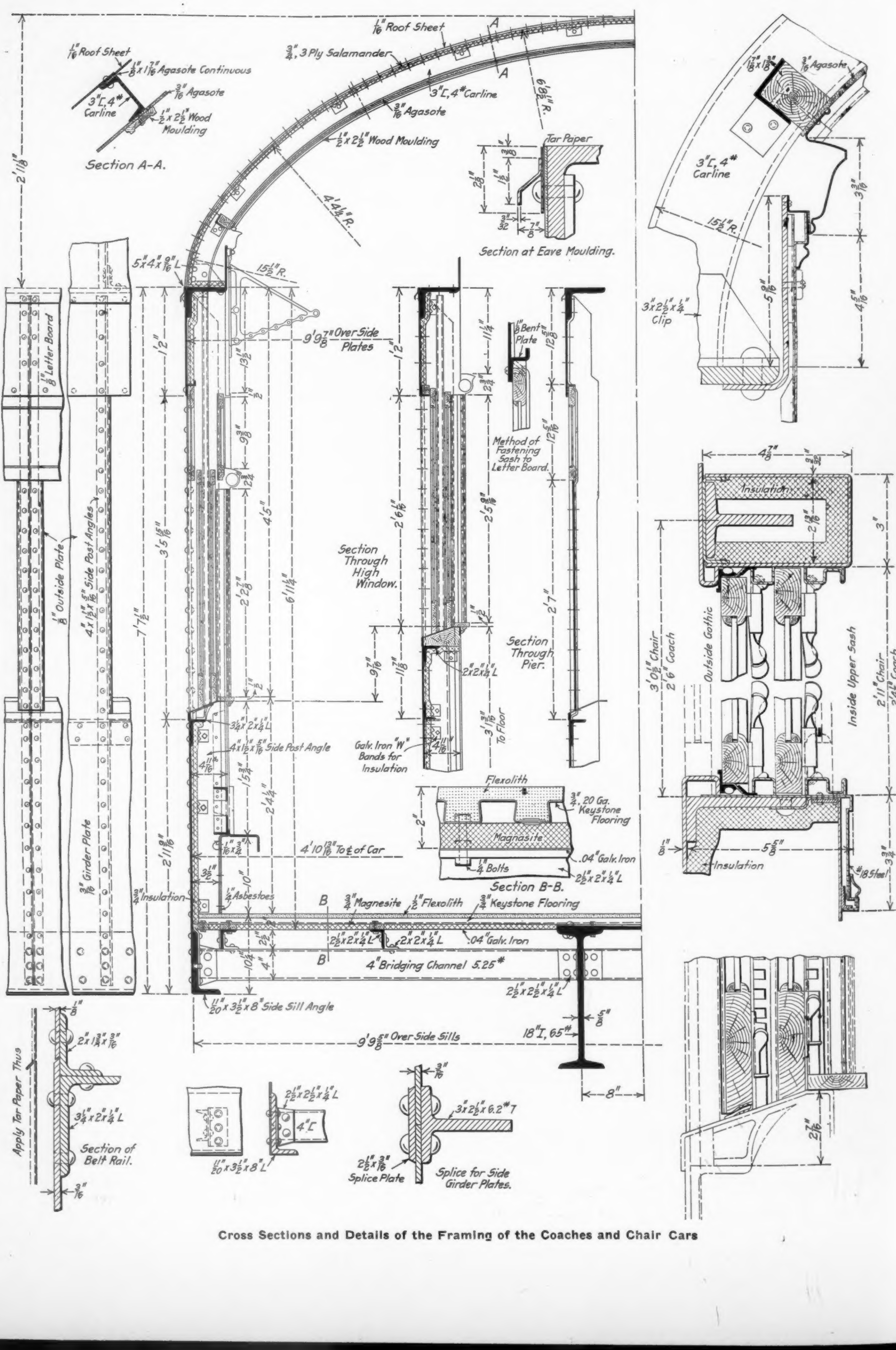


Floor Plan of Union Pacific Baggage-Buffet Car

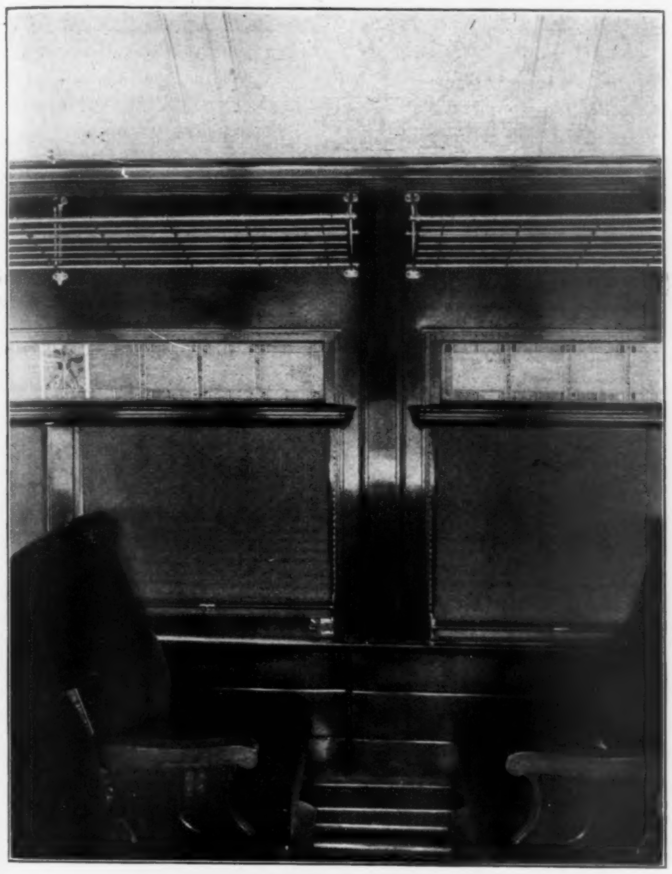




Arrangement of the Frame Members in the Baggage Car



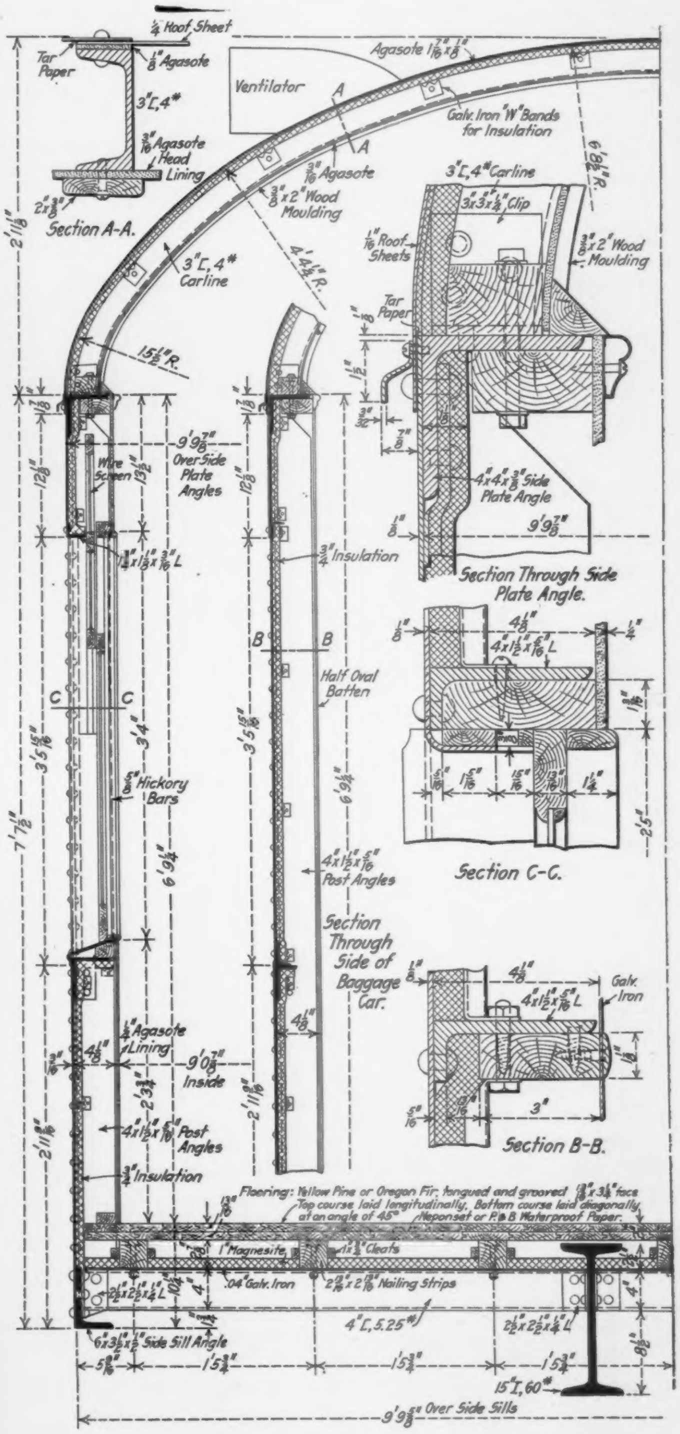
Cross Sections and Details of the Framing of the Coaches and Chair Cars



Interior Finish of the Chair Cars and Coaches

Arrangement of the Interior of the Postal Cars

side plate is formed of a 5-in. by 4-in. by 9/16-in. angle, while the side posts are 4-in. by 1½-in. by 5/16-in. angles, the belt rails being 3¼-in. by 2-in. by ¼-in. angles with 2-in. by 1⅜-in. by 3/16-in. angles riveted to the top. The side door posts are 4½-in. by 3-in. by 5/16-in. angles. The end construction of these cars is of the dummy type, the end sill being a steel casting, while the two center posts are 10-in., 30-lb. I-



Cross Sections Through 60 Ft. Baggage and Postal Cars

beams. The corner post is built up of a 4-in., 8.2-lb. Z-bar and a 3-in. by 3-in. by ¼-in. angle reinforced by wood, and between the corner post and the center post are two 4-in., 8.2-lb. Z-bar posts. The end of the car is covered with 3/16-in. plate as far as the belt rail, above which ⅛-in. plate is used, while the end carline is a 4-in. by 4-in. by ⅜-in. angle. The end plate of the car is also a 4-in. by 4-in. by ⅜-in. angle.

In the postal cars and the 60-ft. baggage cars the center sills consist of 15-in., 50-lb. I-beams, but no cover plate is employed. The side sill is a 6-in. by 3½-in. by ½-in. angle and 4-in., 5.25-lb. channels are used as supports for longitudinal nailing strips, to which the double board floor is secured.

The special equipment used on these cars includes New York air brakes, Chicago Car Heating Company's vapor system, Commonwealth cast steel truck frames, Creco brake beams, Pitt couplers, Sessions friction draft gear, Waugh-Forsyth buffing device, Acme vestibule diaphragms, Utility ventilators, Transportation Utilities Company's window fixtures, National trap doors, Hale & Kilburn seats, Adams & Westlake's sanitary bubbling water fountains and white metal washstands, Duner flush closets, Johns-Manville Salamander hair felt insulation, Keystone floors, Rausch bag racks in the postal cars, Edison storage batteries and Gould axle lighting generators.

STEEL SUBURBAN CARS FOR THE ERIE

A train of eight suburban passenger cars of all-steel construction, consisting of seven coaches and one combination baggage and smoker, has recently been placed in service by the Erie Railroad. The cars were built by the Pressed Steel Car Company, Pittsburgh, Pa., from designs prepared by L. B. Stillwell, consulting engineer, New York.

The design of these cars was made with a view to meeting the following conditions: Safety and comfort of passengers; low cost of operation; low cost of maintenance, and moderate first cost. In general their construction is similar to that of the New York, Westchester & Boston electric suburban cars, described and illustrated in the May, 1912, issue of the *American Engineer*, page 238, and while they are built for steam operation, provision has been made for the ultimate addition of electric motive power equipment. One of the points of greatest interest in the construction of these cars is the arrangement of the superstructure, whereby all parts contribute to its strength to withstand shocks of derailment, overturning or collision. Other notable features are the light weight per seated passenger and the easy-riding qualities which have developed in service.

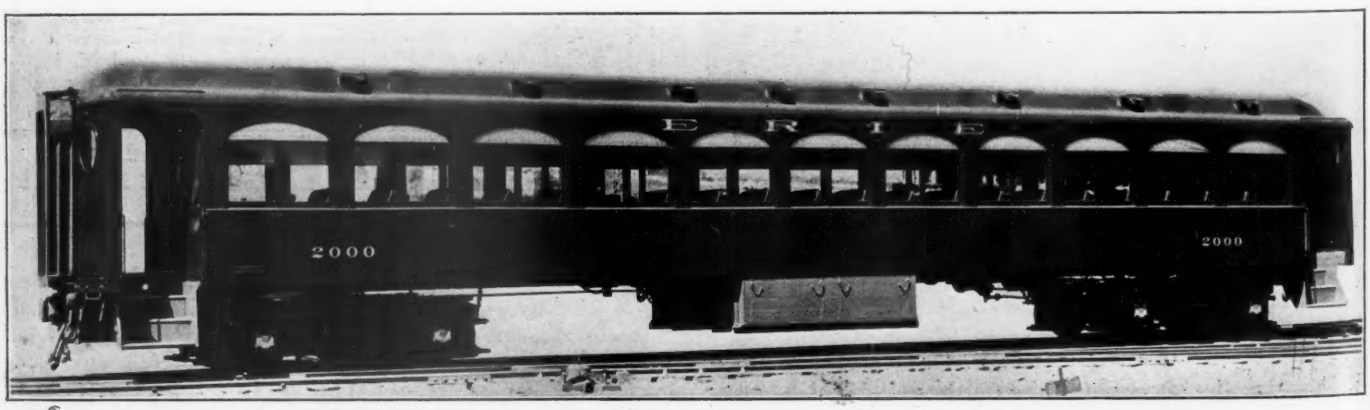
The coaches are 70 ft. 4 in. long over-all and weigh complete 95,400 lb. The table of comparative weights of Erie passenger equipment shown on this page shows that the total weight is less than that of two classes of steel underframe passenger cars having a smaller seating capacity. It shows further that the all-steel car weighs less per seated passenger

Interior of the Erie Steel Suburban Coach

and closely approximates the weight per foot of over-all length, when compared with the lightest wooden cars in the same company's service.

The comparison per foot of over-all length is unaffected by the seat spacing, and is particularly interesting in this instance, as the new cars include heavy buffing and friction draft gears, as well as heavy draft sills, whereas the lightest wooden car has only the platforms and wooden draft sills with tandem spring draft gears. The light weight can be attributed to the exclusion of all unnecessary members. The deep and

	New cars, all-steel	Class 1935-1950, steel underframe	Class 1910-1934, steel underframe	Class 1825-1874, wood	Class 1800-1824, wood
Number of seats	86	72	72	72	72
Average weight, lb	95,400	96,500	100,500	83,200	86,600
Weight per seated passenger, lb	1,100	1,340	1,400	1,140	1,200
Weight of lighting equipment, lb	Battery 8,000	Battery 8,000	Battery 8,000	Gas 2,000	Axle Gen. 6,500
Net weight of car, exclusive of lighting equipment	87,400	88,500	92,500	81,200	80,100
Weight per seated passenger, exclusive of lighting equipment	1,017	1,230	1,284	1,128	1,112
Length over-all	70 ft. 4 in.	66 ft. 3½ in.	66 ft. 3½ in.	66 ft. 3½ in.	66 ft. 3½ in.
Weight per ft. of over-all length, exclusive of lighting equipment	1,243	1,333	1,395	1,225	1,210

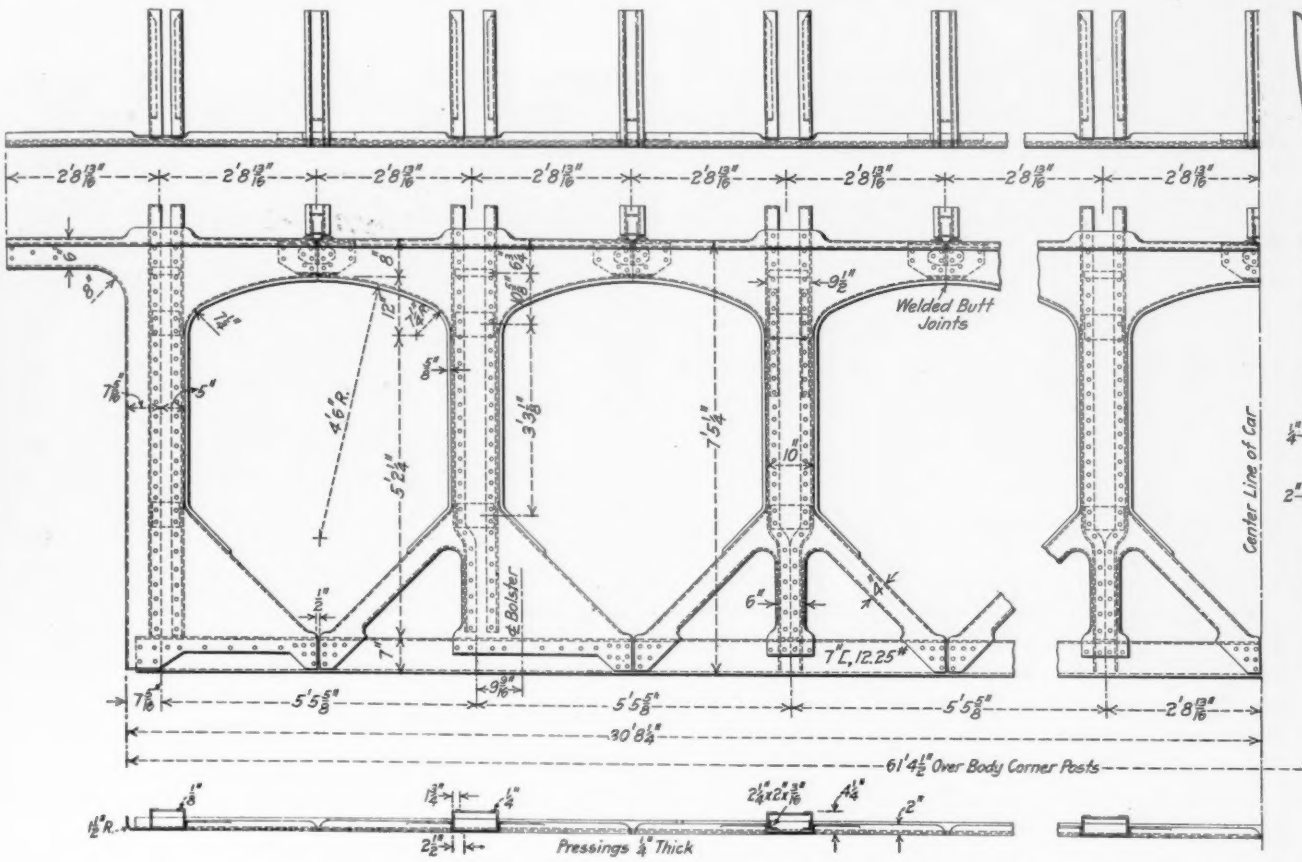


Erie All-Steel Suburban Coach

heavy center sill construction of the fishbelly type has been dispensed with, and sills of uniform section are supported by the deep side frame through a system of crossbearers.

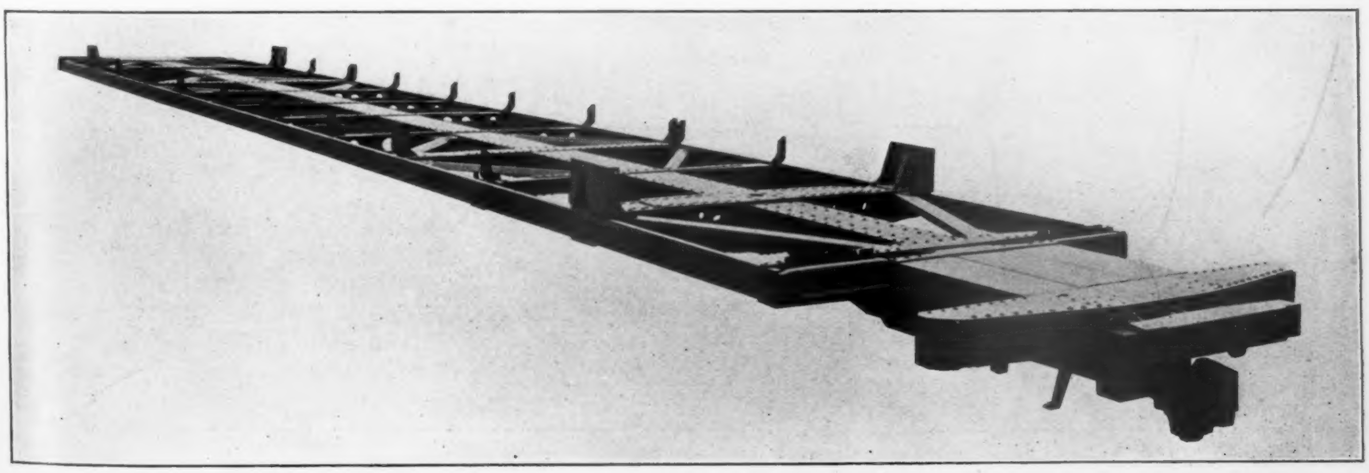
Provisions for application of electric motive power equipment consist in the suitable height and outline of roof to permit of application of overhead current collector if required: the arrangement of vestibule for application of platform control equipment; the arrangement of underframe members for the support of electrical motive power equipment in the most advantageous manner for operation and for thorough inspection and maintenance of apparatus, and the design of draft sills, bolster and trucks to provide clearance for electric motors.

The center sill construction of these cars is of uniform depth and section between bolsters, and consists of two 8-in. 16.25-lb. channels spaced 14 in. back to back, with a 19-in. by 3/8-in. top cover plate and two 4-in. by 3½-in. by 3/8-in. angles reinforcing the bottom flanges. This gives a total section of 22 sq. in. Deep pressed steel draft sills extending through the bolsters reinforce the center sills and at the point of maximum depth add 10 sq. in. to the section.



Pressed Steel Unit Side Frame Construction of the Erie Suburban Cars

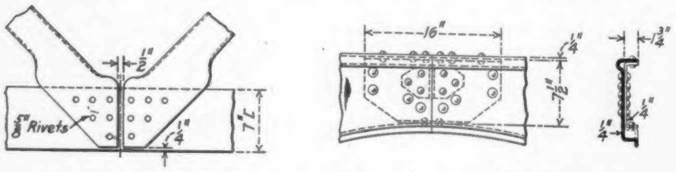
The center sill construction forward of the bolsters is supported by the high side frames through the body end sill and bulkhead construction. The bending moment occurring at this point due to the eccentric draft gear forces is resisted by the draft sills and is transferred by the body end sill and bulkhead construction to the high side frames. The center sill construction between bolsters is thus relieved of any eccentric loading from the draft gear forces, and the full section is available to resist the consequent direct compression because of the support which is afforded by the high side



Underframe; Erie All-Steel Suburban Cars

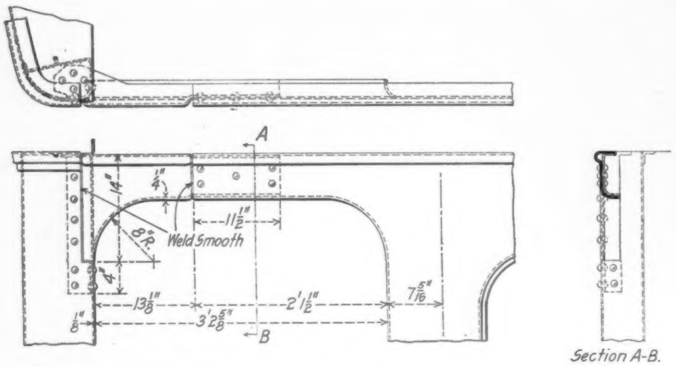
frames and heavy crossbearers placed under the side posts.

The side frames of the car are 7 ft. 5¼ in. from bottom of sill to top of side plate, and are 61 ft. 4½ in. long over body corner posts. The entire frame is designed as a girder, with a pressed steel compression member at the side plate and a 7-in. 12.25-lb. channel tension member at the side sill. The



Details Showing Diagonal Brace Connection to Side Sill and Side Plate Splice

posts connecting these members are of 10-in. pressed channel form, ¼ in. in thickness, and are spaced 5 ft. 5⅝ in. between centers. They are furnished with integral diagonal braces below the windows and with flanged gussets at the portal arches. The vestibule end posts consist of 9-in. I-beams framed into the sills and to the vestibule ceiling construction.



Detail of Vestibule Corner Post Connection to Side Door Header

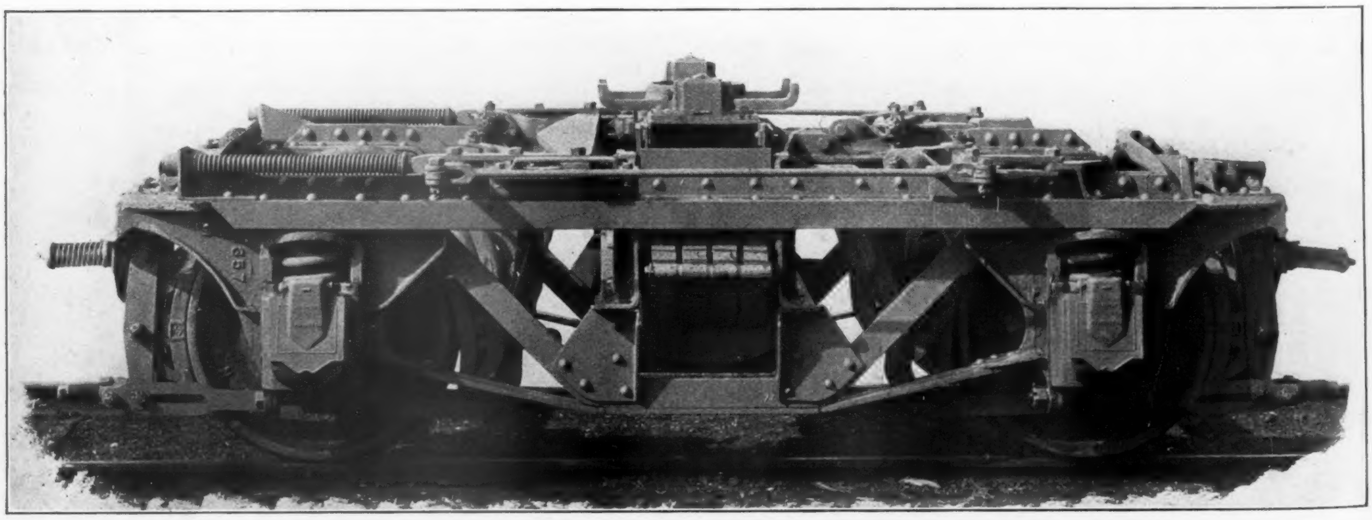
The body end walls are fitted with ¼-in. pressed steel corner posts 12 in. deep, with gusset connections to the side sills and to the side plates of flanged form ¼ in. thick.

The roof structure is formed of pressed channel carlines, and is of the compound arch type. This form of roof is not only strong, light and inexpensive, but gives good ventilation, good distribution of reflected light and is particularly suitable for the support of electric current collectors.

The trucks are 47 ft. 7½ in. apart from center to center and are of a non-equalized type, generally similar to those on the Westchester cars previously referred to. They are fitted with coil journal box springs and long quadruple elliptic springs under the bolsters. The proportioning of the springs is such as to produce the easy-riding qualities essential in steel car construction, not only for the comfort of the passengers but for the maintenance of equipment and roadbed. The trucks have an 8-ft. wheel base and complete, with clasp brakes and 33-in. wheels with 5-in. by 9-in. journals, weigh 12,500 lb. each.

Interior View of the Completed Framing; Erie Suburban Cars

These trucks are designed with ample clearance for the application of electric motive power equipment, if at any future time their use in such service is required. Other features of interest on the trucks are Coleman bolster locking center pins which prevent the separation of car body from truck in case of derailment or collision, and clasp brakes, which greatly reduce brake shoe and journal wear and facilitate smooth stops, which is an especially desirable feature.



Truck Used on the Erie All-Steel Coaches

The illumination of these cars is secured by eleven electric fixtures arranged in the center line of the car. One 25-watt lamp is used on each fixture. Power for lighting is furnished by an 800 ampere hour Wilson storage battery.

The equipment includes Miner Friction draft gear and buffing device; Pitt couplers and Hale & Kilburn seats.

SHOP PRACTICE

REDUCING PISTON VALVE LEAKAGE

BY V. T. KROPIDLOWSKI

In spite of all precautions in fitting up piston valves, there is a certain amount of steam that finds its way past the rings to the exhaust side without doing any useful work. The amount thus lost depends almost entirely on the practice followed in the repair shops in repairing and fitting up the valves. The methods established in one shop with which the writer is familiar have brought about a very noticeable reduction in steam leakage, and

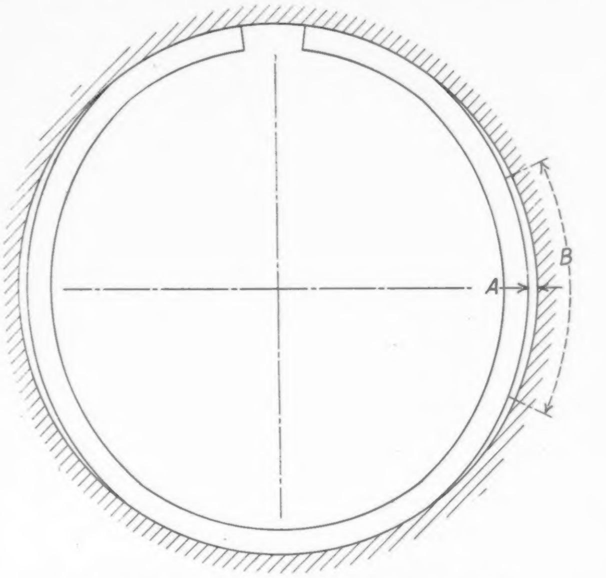


Fig. 1—Effect of Using Large Packing Ring

some of the tools developed for use in connection with this work are worthy of attention.

The practice quite commonly followed in railroad shops is to bore the valve chamber bushings to the exact diameter in the main shop, leaving the outside diameter to be turned to fit the chamber at the point of application. This has been found un-

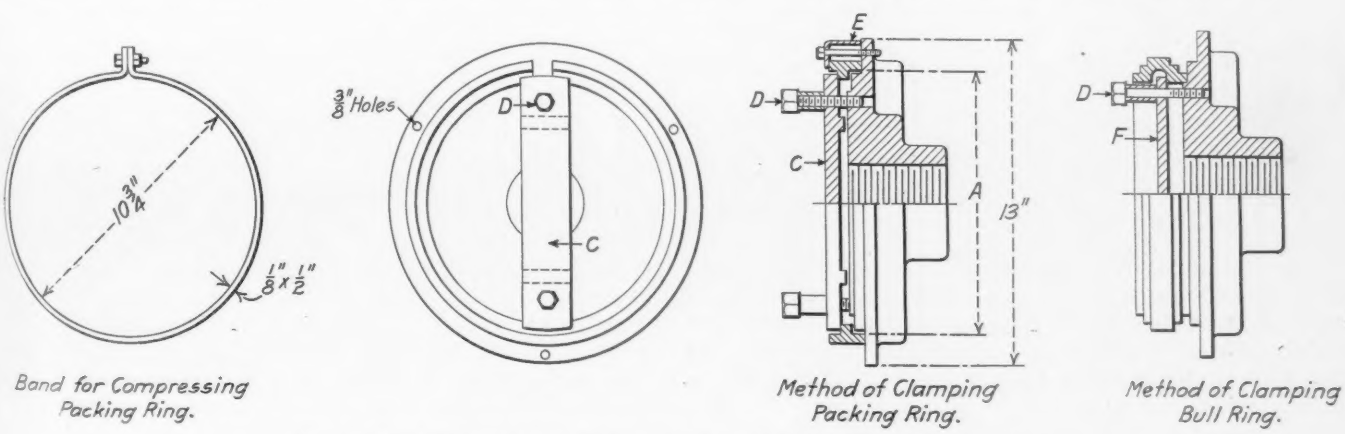


Fig. 2—Chuck for Finishing Valve Chamber Packing Rings and Bull Rings

satisfactory, as in every case, after a bushing has been pressed in, it is found to be out of round. There are two reasons for this: One is that the cylinder may have been warped from long service and the continual contraction and expansion; the other is that the bushing itself may be warped. Every casting tends to distort when the scale is turned off, due to the unbalancing of internal stresses caused thereby. In a casting such as the bushing of a valve chamber this distortion is pronounced, due to the comparative thinness of the walls, and no matter how perfect the bushing has been bored, it will be found out of round after the outside has been turned. It is, therefore, bad practice

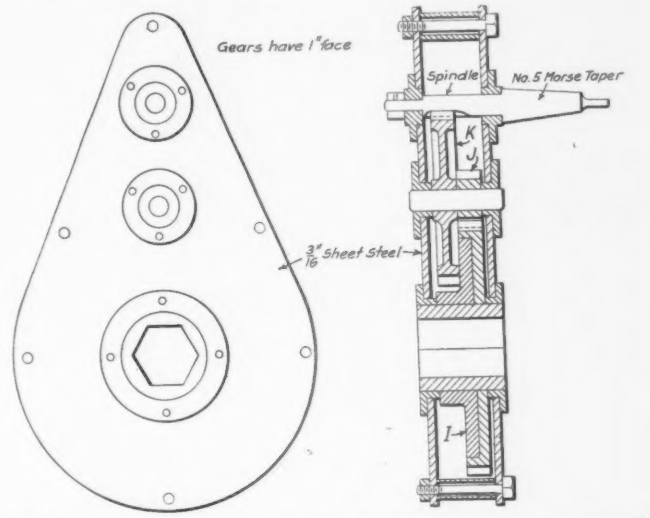


Fig. 3—Gear Train Used in Pulling in Valve Chamber Bushings

not to provide for boring the bushing after it has been pressed in the chamber.

Another practice, not in accordance with the best results, is the maintenance of stock sizes of packing rings. Because of this practice packing rings as much as 1/8 in. to 3/16 in. larger than the bore are being used in repair work. This results in oval instead of perfectly round packing rings when they are placed in the chamber. Actual measurements, taken at various times, of rings finished 1/8 in. larger in diameter than the bushing, when in place in the chamber, have been found to vary from 1/32 in. to 3/64 in., as shown at *A*, Fig. 1, and a sheet of paper of the ordinary letterhead thickness, measuring .0025 in., could be slipped along between the ring and the wall of the chamber a distance of 4½ in. to 5½ in., as indicated at *B*, Fig. 1.

There is but one way to provide perfect fitting packing rings. After having turned the rings to the diameter that will give the required spring or tension, they must be cut, then closed and turned to the exact diameter of the chamber. To do this work the chuck, shown in Fig. 2, was made from a cast-iron piston head. The packing ring is first closed till the smallest diameter of its slightly

oval form is a little larger than the bore of the valve chamber, with a band clamp, and with the clamp in position is then placed on the chuck. The diameter at *A* is slightly less than the inside diameter of the ring, to permit centering it with reference to the outside surface, when the chuck has been screwed onto the lathe spindle. When centered the ring is firmly clamped to the chuck by the bar *C* and bolts *D* and the band removed, the bar *C* holding it in the closed position while it is turned. Old packing rings can be turned in the same manner. If the inside of old rings need truing up, clamps *E* are used instead of bar *C* to hold the ring in place.

Bull rings may also be turned up on this chuck, by using a shorter bar, shown at *F*, in place of bar *C*, the ends resting on the edge of the cored annular cavity inside of the bull ring. The same bolts may be used with both bars.

A very convenient arrangement has been also devised for pulling the valve chamber bushings into the cylinder. This is shown in Fig. 3 and consists of a threaded rod, two heads, one of which bears against the outer end of the bushing and the other against the opposite end of the valve chamber, a train of gearing and an air motor. The gear train is assembled in a casing, an air motor is attached to the driving shaft and the hollow driven shaft is designed to slip over the nut on the threaded rod. The gear train is very powerful and enables one man to attend to the pulling in of the bushings. The pitch diameters of the gears and the number of teeth are as follows:

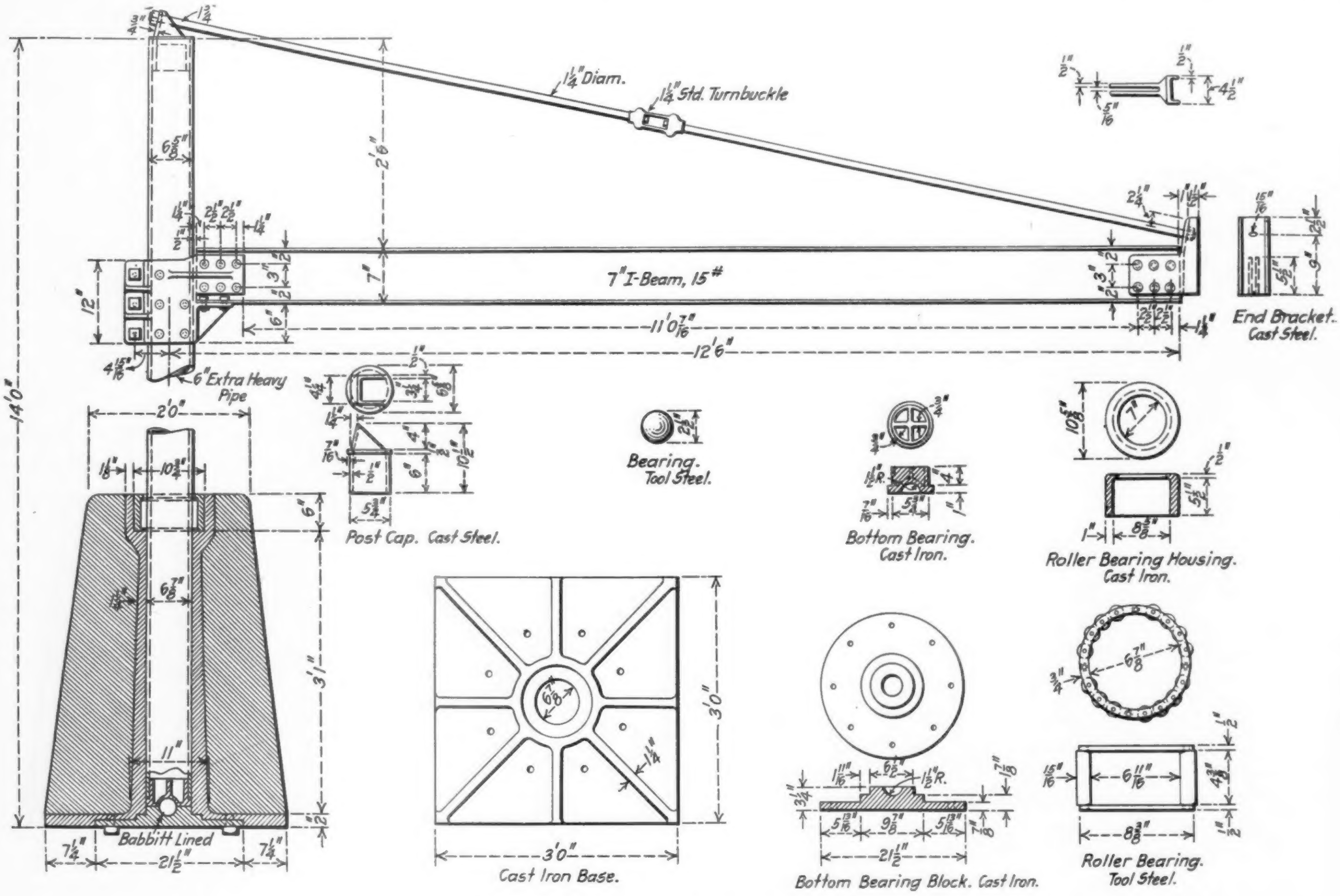
Gear *I*	11½ in. pitch diam.,	115 teeth
Gear *J*	2 in. pitch diam.,	18 teeth
Gear *K*	8 in. pitch diam.,	80 teeth
Spindle	1½ in. pitch diam.,	13 teeth

No tests have been made, either prior to or after the inauguration of the practice of maintaining piston valves herein described, to determine its effect upon leakage. There is, therefore, no specific data as to the amount of reduction effected, but general observations have shown that it is considerable.

PILLAR CRANE FOR MACHINE TOOL WORK

The pillar crane, the details of which are shown in the engraving, was designed especially for serving machine tools. It is very simple in construction and is easily rotated in the base. The pillar is a piece of 6 in. extra heavy pipe into the lower end of which is fitted a bottom bearing of cast iron. Into the upper end is fitted a cast steel post cap to which the end of the tension rod is secured. The jib member is a 7 in., 15-lb. I-beam secured to the post by a special cast steel connection which is riveted both to the beam and the post.

The pillar is supported in a cast iron base 3 ft. square and 3 ft. 9 in. high bored slightly larger than the pillar. A bottom bearing block is bolted to the base, in the upper face of which is a babbit-lined hemispherical recess. In this and a similar recess in the pillar bearing runs a tool steel ball 2½ in. in diameter. The top of the base is counterbored to receive a housing 10⅝ in. in diameter, which contains a roller bearing running on the post.



Details of Self-Contained Pillar Crane

When assembled, the base is embedded in the ground to a depth of about 12 in.

This crane was designed by A. L. Graburn, mechanical engineer, Canadian Northern, Toronto, Ont. It is used with a chain hoist, which is suspended from a four-wheel trolley mounted on the lower flanges of the I-beam.

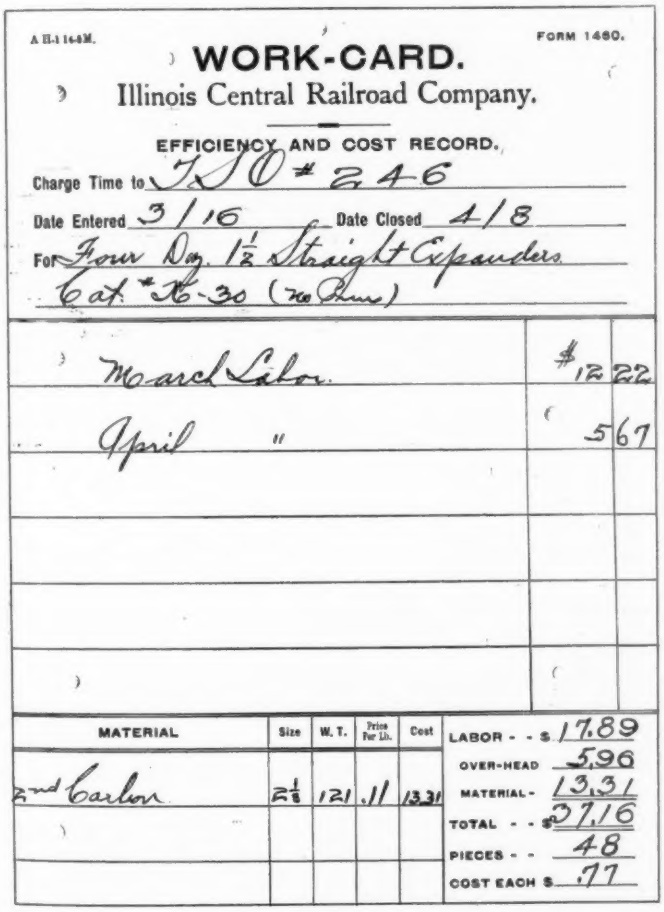
DISCOVERY OF OXYGEN.—The discovery of oxygen is generally credited to Dr. Joseph Priestly, an English clergyman and scientist. The date, August 1, 1774, is commemorated as the birthday of modern chemistry. At about the same time two others made the same discovery: Scheel, a Swedish apothecary, who called it "fire air"; and Lavoisier, a French chemist, who called it oxygen, meaning "acid former." To Lavoisier is due the credit for the true explanation of combustion.—*Power.*

Illinois Central Tool System

Standardization and Distribution Include a Central Tool Room with an Accurate Cost System

BY OWEN D. KINSEY
Tool Foreman, Illinois Central, Burnside Shops, Chicago, Ill.

The tool system of the Illinois Central is conducted along lines similar to those employed in a commercial manufacturing institution, as regards manufacturing methods and cost accounting. Centralization of functions is productive of economy. To maintain a standard shop practice throughout a railroad system there must be a standardization of tools and definite restrictions placed on their manufacture at outside points. Many standard tools, such as taps, drills, reamers, etc., can be purchased from the commercial tool manufacturers at a lower cost than they can be made in even a well equipped central tool room. It is therefore imperative that production costs be carefully compared in justice to both the commercial tool manufacturers and the railroad.


A H-1 14-4M. FORM 1460.

WORK-CARD.

Illinois Central Railroad Company.

EFFICIENCY AND COST RECORD.

Charge Time to T.S.O. # 246

Date Entered 3/16 Date Closed 4/8

For Four Doz. 1½ Straight Expanders Cat # K-30 (no Run)

March Labor.	$12	22
April "	5	67

MATERIAL	Size	W. T.	Price Per Lb.	Cost
2nd Carbon	2⅛	121	.11	13.31

LABOR - - $ 17.89
OVER-HEAD 5.96
MATERIAL - 13.31
TOTAL - - $ 37.16
PIECES - - 48
COST EACH $ .77

Work Card Used in the Illinois Central Tool Room

It stands to reason that a small shop cannot produce good tools at a cost low enough to warrant their production, because it is not equipped for such work and cannot manufacture in quantities sufficiently large to obtain a low production cost. Moreover, a uniform shop practice is impossible, due to the varying ideas or notions of each individual foreman. Therefore, standardization is lost sight of and expensive duplicate jigs and devices are made and used at several points, while one device would serve the entire system, making all tools standard and resulting in a standard shop practice.

There is a natural tendency to underestimate manufacturing costs, and although such expenses as those for jigs, dies, fixtures, small tools, lubricants, files, power, light and numerous other incidentals, enter into the manufacturing cost of tools they are often ignored in calculating this cost. It is therefore of prime importance that tool manufacture should be centralized and an accurate cost system maintained. The real function of the central tool room is therefore the standardization and manufacture of special tools and labor saving devices, such as cannot be profitably purchased outside. In this there is a broad field and many opportunities for economy.

STANDARDIZATION

Realizing the importance of standard tools throughout the system and the many advantages of centralizing their manufacture at one point, both from the standpoint of economy and that of standardization, a comprehensive central tool supply system has been inaugurated on the Illinois Central. Our first steps were to get away from the practice of making tools from worn-out samples and by hit-or-miss methods. A draftsman was assigned to the central tool room and a careful study made of each tool, considering efficiency, conditions under which it is used, safety and cost of manufacture. We went into the matter thoroughly, consulting the shop foremen and incorporating the very best ideas obtainable into a standard drawing, care being taken to eliminate overlapping sizes. These drawings were made up in standard folio size and copies of each mounted on cardboard for the convenience of the workmen. The value of standard drawings can hardly be overestimated. They relieve the foremen of lengthy verbal explanations and make it impossible for a workman to misunderstand what is wanted.

Several workmen can be assigned to the same job, each producing a certain part or number of parts, requiring no inventive or designing ingenuity on his part, as the article to be produced is clearly defined by the drawing. Consequently he produces more and better work, having a clear understanding of just what is wanted. Without a drawing, the average mechanic is quite likely to take his problem too seriously and make his work too expensive, being obliged to plan as he goes along, and the time thus spent would be taken care of once and for all if a drawing were followed. The fact is, when standard drawings are followed out and jigs and similar devices are used, a great increase in production results. Some of the least efficient workmen of the old system become the most efficient of the new.

Jigs, as a rule, are not expensive to make; in fact, they can in most cases be made up very inexpensively, providing artistic tool-making notions are secondary to performance and cost. It is nonsense to allow a skilled mechanic, whose time is more valuable for other work, to "putter" around with an elaborate set of fine instruments, laying out dimension lines to be followed by eye in the machining operations, when a simple, inexpensive jig will produce more accurately ten parts to his one in the same time. Such conditions are to be found in the smaller shops when tool making is undertaken, while repairs to jacks, hoists, pneumatic tools and other necessary shop appliances are sadly neglected.

CATALOG

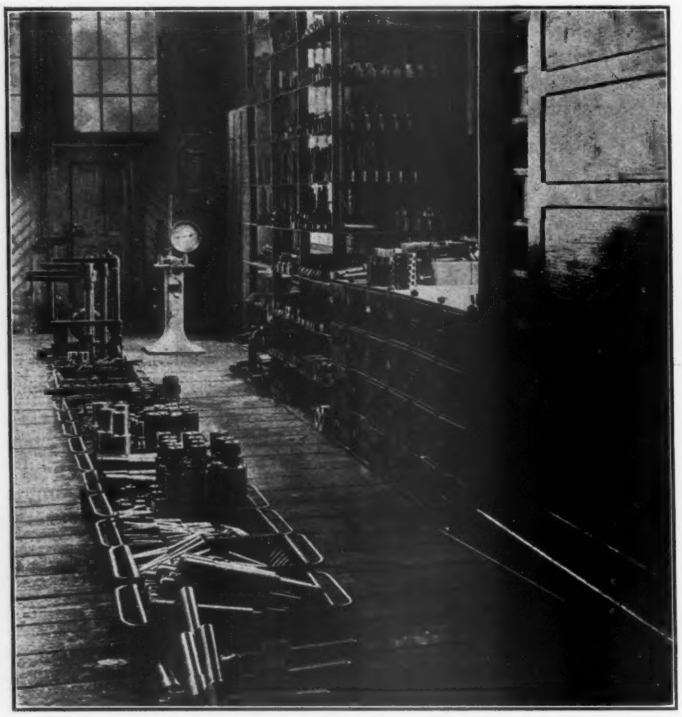
All tools manufactured in the central tool room are listed in classified order in a standard tool catalog. This catalog is contained in a loose leaf binder so that it can be added to as the system grows. The catalogs are distributed to the several di-

vision storekeepers and master mechanics at the outside shops, and when tools are required a special requisition is made out giving the catalog number of the item wanted. This system eliminates all possibility of the order being misunderstood, providing the catalog number is correctly given, and also saves much time in writing. After being approved by the general inspector of tools and the superintendent of motive power, it goes through the general storekeeper's office directly to the central tool room to be filled.

STOCK

The tool stock is carried in the central tool room for convenience, although it is the property of the store department and is carried in their stock account. The tools are stored and handled in the same manner as the regular storehouse stock, being listed in the standard stock book from actual inventory taken on the first of each month. This record at all times shows the amount of individual tools in stock as follows: name of tool, catalog number, shelf or drawer, number on hand on the first of the month, number manufactured during the month, and number shipped. This is, in reality, a perpetual inventory.

The manufacture of stock tools is left largely to the discretion of the tool foreman, under supervision of the general storekeeper. It is of course, under this system, to his best interests that the stock be kept as low as possible, consistent with maintaining a good service to the mechanical department. All material entering the central tool room is charged to the central tool room material account, which is designated by standing shop order No. 1,017. This material, after entering the central tool room stock, is still the store department's property and is listed in the stock book as raw material.

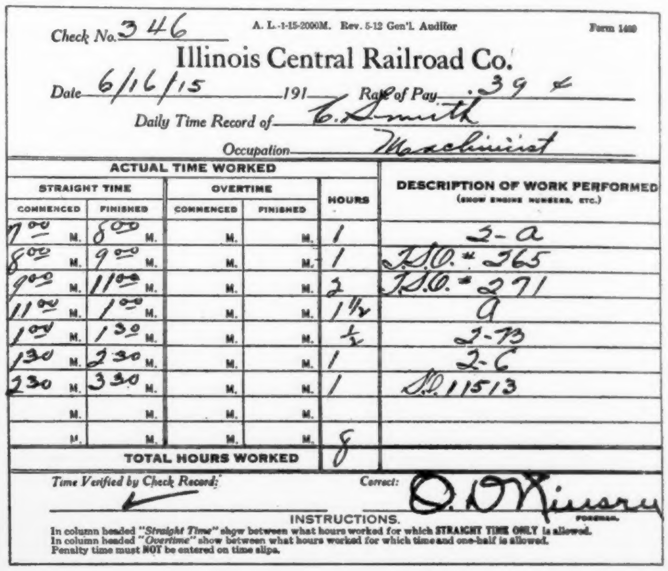


Stock Racks and Material in Process of Manufacture

The manner in which the store department co-operates with the central tool room in supplying raw material for manufacturing purposes and information relative to commercial tool costs for purposes of comparison, emphasizes the ideal co-operative service between the supply and mechanical departments. A representative from the store department consults the tool foreman each month before sending in an order for manufacturing material, checking over item by item the material on hand and the possible requirements for the coming month. This plan eliminates the carrying of a large stock and guesswork on the part of the stock keeper, who, without a definite understanding of requirements, would quite likely order a little of everything and still not have much of anything.

SYSTEM OF MANUFACTURE

When it is desired to manufacture a certain tool or a number of tools for stock, a tool room shop order is issued by the tool foreman. For instance, T. S. O. No. 246 is made out, which calls for the manufacture of four dozen 1½-in. straight expanders (without pins). As soon as the material is taken from the steel rack and the turret lathe work completed, the weight of material used is calculated from measurement and the grade and size, together with the weight, is entered on the work card as shown in one of the illustrations. The material now changes from raw material to material in process of manufacture, and if at the end of the month when the account books are closed it is not complete, it is taken into inventory as semi-finished material. The work card shown is a true copy of an actual performance, and it will be noted that the unit cost is extremely low if compared with the cost of a commercial expander. The fact is, we have found that nearly all flue tools can be produced in a central tool room at a much lower cost than that for which they can be purchased.



Check No. 346 A. L.-1-15-2000M. Rev. 5-12 Gen'l. Auditor Form 1400

Illinois Central Railroad Co.

Date 6/16/15 191 Rate of Pay .39 ¢

Daily Time Record of C. Smith

Occupation Machinist

ACTUAL TIME WORKED					DESCRIPTION OF WORK PERFORMED (SHOW ENGINE NUMBERS, ETC.)
STRAIGHT TIME		OVERTIME		HOURS	
COMMENCED	FINISHED	COMMENCED	FINISHED		
7 00 M.	8 00 M.	M.	M.	1	2-a
8 00 M.	9 00 M.	M.	M.	1	T.S.O. # 265
9 00 M.	11 00 M.	M.	M.	2	T.S.O. # 271
11 00 M.	1 00 M.	M.	M.	1½	a
1 00 M.	1 30 M.	M.	M.	½	2-73
1 30 M.	2 30 M.	M.	M.	1	2-C
2 30 M.	3 30 M.	M.	M.	1	S.O. 11513
M.	M.	M.	M.		
M.	M.	M.	M.		
TOTAL HOURS WORKED				8	

Time Verified by Check Record: ✓ Correct: [illegible] Foreman.

INSTRUCTIONS.

In column headed "*Straight Time*" show between what hours worked for which STRAIGHT TIME ONLY is allowed.
In column headed "*Overtime*" show between what hours worked for which time and one-half is allowed.
Penalty time must NOT be entered on time slips.

Tool Room Time Ticket

The manner in which this particular job was done may be of interest. The first operation is performed on a 3 by 36 hollow hexagonal turret lathe, where it is shaped by forming tools to standard templates, drilled and cut off. The second operation is performed on a 24-in. radial tool room drilling machine, where it is chucked and reamed to size with a spiral taper reamer. The third operation is the sawing into sections on a triple head milling machine, three expanders being sawed at one operation. For the fourth operation the piece is passed to a bench hand who marks and separates the sections. The fifth takes place at the electric furnaces where it is hardened and drawn; and for the sixth, it returns to the bench for assembling.

All material in process of manufacture is handled in convenient metal pans which are lined up adjacent to the foreman's desk, as may be seen in the accompanying photograph. Each workman, when assigned to a shop order, takes the material from this section and returns it when his operation is completed. This plan prevents the work from being scattered around the shop and lost track of, and also enables the foreman to assign work with the least possible delay, a point very important in an efficient organization.

ASSIGNING WORK AND CHECKING TIME

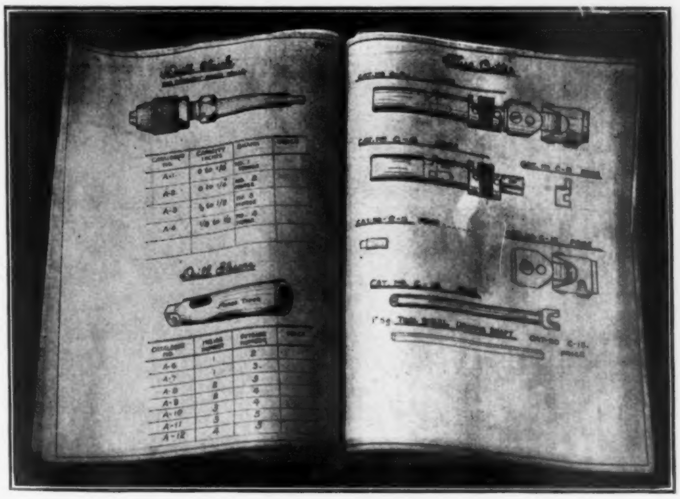
All work is assigned from the foreman's desk and a time ticket, like the one illustrated, is handed the workman, to-

gether with a blue print defining the tool to be produced. For instance, the workman is started on T. S. O. No. 150 at 7 a. m., which starting time is entered on his time ticket by either the foreman or the time checker, who sits at a desk adjoining the foreman's. The workman completes his job and returns it, presenting his ticket to be assigned another job. The time finished is entered and a new job assigned, which starts at the same time he finished the previous operation, and so on, his record being kept in this way throughout the day. This system gives a correct time accounting and also records the performance of the workmen, a fact well known by them, resulting in a surprising increase in individual efficiency, the full meaning of which is better appreciated by reviewing the monthly expense and production statements.

Under the old system each workman kept his own time record, turning in a ticket at the close of the day's work. Nine times out of ten he would remember about half of the charges worked on during the day and then guess at the other half, some familiar general expense charge usually being used. A noticeable evil of the system was that the workmen would, in order to accommodate the foreman, knowing that he is trying to get a low production cost, cut off a little time from the actual time worked, to help matters along. The new system gives a correct time record. All charges are made to a T. S. O. account, or to the standing shop order in the event of some small job on which a cost has already been obtained. There is no general expense account such as shop machinery and tools or tool repairs. If time is spent in making repairs to a tool room machine or grinding tools, and similar work, the workman charges his time to account A, which is the central tool room expense account. This expense is taken care of when the books are closed at the end of the month.

SHIPPING

Tools for shipment to outside points are wrapped for shipment in the central tool room and delivered to the storekeeper.



Illinois Central Tool Catalog

together with requisition showing the charges. If the order is filled in full, the requisition is held by the store department, but if not, it is returned after being checked with the goods delivered. The tool room copies the order into a record book when first received, which serves as their record.

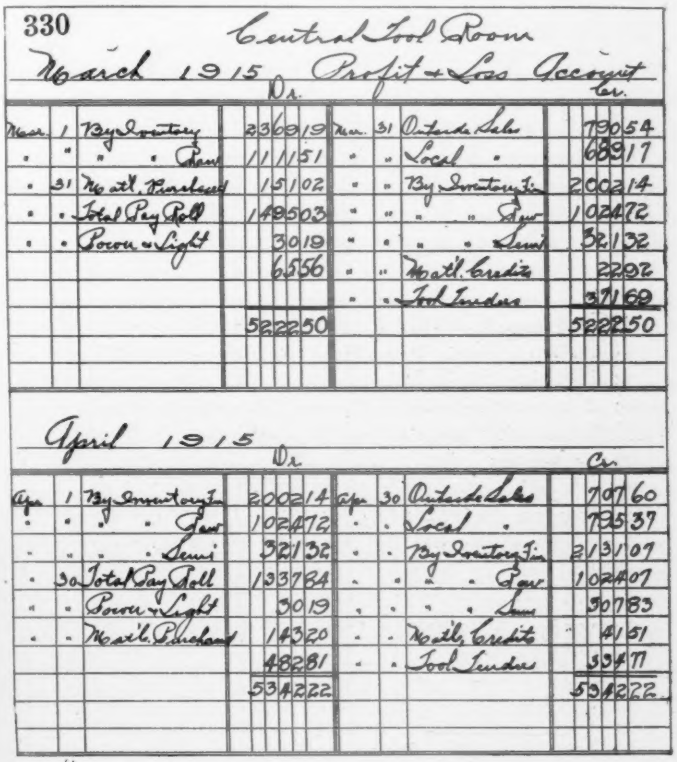
ACCOUNTING

The pricing of goods shipped is done by the tool department. When a shipment is made up, the price of each article is entered on the requisition which goes with the goods to the store department, this serving as an invoice of the goods shipped. A double-entry bookkeeping system is maintained and the books are closed into profit and loss account at the end of each month to ascertain whether the selling prices are high enough to cover all expenses. All work delivered from the central tool room is regarded as a sale and an entry made in the journal charging the consignee and crediting sales. A card index record of all goods shipped to outside points is kept for reference purposes. The Burnside shops are handled in the same manner as outside points as regards new tools.

For running repairs to small tools each department is designated by an account number as follows:

2-A Machine Shop Tool Repairs.
2-B Boiler Shop Tool Repairs.
2-C Blacksmith Shop Tool Repairs.
2-D Tin Shop Tool Repairs
2-E Round House Tool Repairs.
2-F Car Dept. Tool Repairs.
2-G 27th Street Round House Tool Repairs.

During the month a great number of small jobs are handled in the same manner as tool shop order accounts, as may be seen



330 Central Tool Room

March 1915 Profit & Loss Account

Dr.				Cr.			
Mar.	1	By Inventory	2369 19	Mar.	31	Outside Sales	790 54
"	"	" " Gov	1111 51	"	"	Local "	689 17
"	31	Mat'l. Purchased	151 02	"	"	By Inventory Fin	2002 14
"	"	Total Pay Roll	1495 03	"	"	" " Gov	1024 72
"	"	Power & Light	30 19	"	"	" " Semi	321 32
			65 56	"	"	Mat'l. Credits	22 92
				"	"	Tool Tenders	371 69
			5222 50				5222 50

April 1915

Dr.				Cr.			
Apr.	1	By Inventory Fin	2002 14	Apr.	30	Outside Sales	797 60
"	"	" " Gov	1024 72	"	"	Local "	795 37
"	"	" " Semi	321 32	"	"	By Inventory Fin	2131 07
"	30	Total Pay Roll	1337 84	"	"	" " Gov	1024 07
"	"	Power & Light	30 19	"	"	" " Semi	307 83
"	"	Mat'l. Purchased	143 20	"	"	Mat'l. Credits	41 51
			482 81	"	"	Tool Tenders	334 77
			5342 22				5342 22

Tool Room Profit and Loss Account

from the accompanying facsimile of a time ticket. All of these charges appearing on time tickets are taken off in the shop timekeeper's office and distributed to the same account in the distribution book. At the end of the month the central tool room is rendered a statement showing the total time charged to each account, and is also given a total pay roll statement which includes all tool room labor and supervision expenses.

At the end of the month, when receiving this statement showing the total charges made against each department of the Burnside shops and shop order charges, we close our work cards or shop orders in the manner shown in the illustration. An overhead charge is used. These prices constitute our selling prices from which all goods are billed out. We dispose of Burnside accounts in the same manner, adding the overhead to each total, and then make an entry in our journals as follows:

May 31.	Machine Shop ....Dr.	$225.15	
	To Repairs on Small Tools.		
	Month of May.		
	Sales ....Cr.		$225.15
May 31.	Boiler Shop ....Dr.	$80.40	
	To Repairs on Small Tools.		
	Month of May.		
	Sales ....Cr.		$80.40

The next step is to close the ledger into profit and loss account. The total of sales shows us at a glance how much busi-

ness we have handled, while a comparison of the inventory taken on the first and last of the month shows the increase or decrease in the stock, etc. The store department renders a statement of material purchased at the close of each month, which, with the other debits and credits, enables us to close our books into profit and loss account, as shown in the illustration, and thereby determine whether or not we are covering our expenses.

The balance so far has appeared in the debit column, which indicates our selling prices are a little higher than necessary to cover the expenses. Our catalog prices are from 25 to 100 per cent or more lower than the commercial tool manufacturers' prices. If we cannot manufacture an article profitably we discontinue its manufacture altogether.

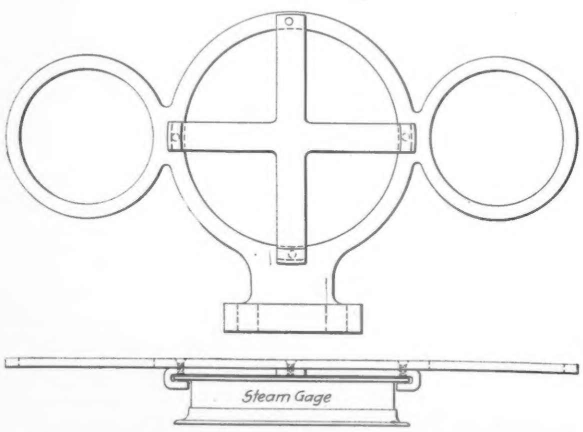
The many advantages resulting from business management can only be appreciated when comparisons with old methods are made. The central tool room has actually decreased its operating expense from $1,856.80 in 1912 to $1,337.84 (pay roll) in the same month of 1915. This has been done through reduction in force, there now being seven less men required in the tool department than three years ago, while the work handled has been more than doubled. It will be noted from the profit and loss statement that outside shipments and stock manufactured exceed Burnside orders, whereas but a short time ago the old tool room employed a larger organization at a much greater expense and handled very little outside work. Another noticeable feature of the new arrangement is the utilization of lower priced tool steel for tool manufacture. For instance, by inserting high speed blades in rose reamers, a reamer 2 in. in diameter by 16 in. long being considered, the cost of the raw material if made solid is $8.86; cost for inserted blades as follows: Six pieces high speed steel 1¼ in. by ½ by 3¼ in. weighing less than one pound; and 14 lb. of soft steel worth 1½ cents per pound; or a material expense of approximately 71 cents.

The progress so far made only serves to emphasize the good that can be accomplished through business management in railway shops.

METHOD OF SECURING STEAM GAGES

BY W. S. WHITFORD
General Foreman, Chicago & North Western, Milwaukee, Wis.

The illustration shows a steam gage bracket to which has been applied a simple attachment for holding the gage in position without the use of bolts or machine screws. The device, originated by J. Linnehan, a machinist at this point, is easily made



Attachment for Securing Steam Gage to the Bracket

from strips of 3/16 in. boiler steel, the ends of which at the bottom and sides of the bracket are bent so that they hold the rim of the steam gage securely in place when the pipe union is connected. By disconnecting the union the gage may be removed.

THE COST OF COMPRESSED AIR

BY THOMAS F. CRAWFORD

Twenty years ago when pneumatic tools were in their infancy the installation of an air compressor did not demand the careful study which is now required, because the wonderful saving in time effected by the substitution of air tools for hand tools overshadowed all other costs. Today, however, instead of a luxury to be found in only the best and most progressive shops compressed air is used in every conceivable plant from the two-stall roundhouse on some isolated branch line to the 40-pit main shop at division headquarters.

A careful study of the growth of the compressed air system in the average shop reveals the fact that the original system has been gradually extended by additions, owing to the many and varied uses to which the high pressure air medium has been applied. The original single stage, 200 or 300 cu. ft. compressor has been replaced by a cross-compound machine of 1,500 cu. ft. capacity; and it in turn has now been supplemented by still more modern and economical compressors with capacities ranging from 3,000 to 5,000 cu. ft. of free air per minute. Steel cars have revolutionized shop practice, and today the repair tracks are demanding from 500 to 3,000 cu. ft. of air, where 15 years ago all work was done by hand. This phenomenal development in many cases has bewildered the mechanical department to such an extent that, in spite of the best practice in air compressor construction and installation, enormous losses are daily incurred through improper piping and the lack of study devoted to the very important subject of air distribution.

The false economy of using the old piping as the system is extended is eating up hundreds of dollars every day in the boiler room and on the switchboard. It is a well known fact that the cost of air varies as the pressure varies; in other words it costs more to compress a cubic foot of air to a pressure of 100 lb., than to 90 lb. Consequently any arrangement of piping which will tend to reduce the initial pressure at the compressor will save money. Assume for example that a shop is piped for a certain size compressor and with the increased requirements the management finds it necessary to purchase a machine of double the capacity. Then, as is often the case, owing to the cost of the machine rigid economy is enforced as to further expenditures, with the result that the important question of piping is neglected. The old piping is considered good enough and only the necessary extensions to the car tracks or other important points are made. No engineering study of the subject has been made and the money saved at one end is going up the stack at the other.

This can readily be seen when a few facts concerning compressed air are considered. In the first place loss of pressure due to friction in pipe lines increases very rapidly as the diameter of the pipe decreases. The pressure loss when transmitting 500 cu. ft. of air per minute through 1,000 ft. of 3½-in. pipe amounts to 1.39 lb., with an initial pressure of 100 lb. per sq. in., while if the pipe size is cut down to 3 in. the loss of pressure jumps to 3.08 lb. Globe valves and fittings such as tees and elbows add greatly to the frictional loss and great care should be given to their application. It will, therefore, be seen that it does not require many poor conditions to build up an unnecessary load on the compressor.

Let us consider a compressor with a capacity of 3,000 cu. ft. of free air per minute operating during a 10-hr. day at approximately 100 lb. pressure and assume that by some rearrangement or replacement of piping the frictional transmission load on this machine is reduced 10 lb. What will the saving be? Under ordinary or even good railroad shop operating conditions it will amount to nearly $3 per day which, in a year of 300 days, would be $900. This represents the interest on an investment of from $10,000 to $15,000, which would go a long way in providing new piping and would pay for considerable engineering study.

Another phase of the subject which offers possibilities for considerable saving is the after-cooling and reheating of the air, particularly where the moisture is excessive and the weather conditions such that long exposed lines are greatly affected. This, however, is a refinement and may be left for investigation after the greater faults are corrected. It is mentioned here simply for the purpose of showing the extent of the field that is awaiting attention.

Pipe and hose leakage presents another source of loss which while appearing small, amounts to many dollars annually in railroad operation. Few master mechanics or shop superintendents realize what a leak signifies in dollars and cents. They know it amounts to something and that it should not exist, but their attention is taken up by things which are of more immediate importance as far as their daily duties are concerned. But when it is realized that for every leak amounting to 1/64 in. in diameter on a 100 lb. pressure line there is a loss of 1.2 cents per day, while for a leak amounting to only 1/16 in. there is the enormous loss of 19.35 cents per day, the subject of leaks assumes some importance. Add up all the leaks from New York to Chicago for instance, on one of our trunk line railroads and it will be found that there is quite a sum of money that is simply vanishing into the air.

In the ordinary railroad shop installation having a capacity of from 1,000 to 5,000 cu. ft. of free air per minute it is fair to assume that it is costing from 2.5 cents to 3 cents per day of 10 hours for every cubic foot of air per minute that is compressed, while in smaller plants where single stage compressors and other old types of machines are used, the cost may be much higher. This is particularly true in roundhouses and small shops using tubular boilers without feed water heaters. With these costs as a basis, another field of economy still greater than those already considered becomes evident. It is the operation and care of pneumatic tools.

Even ten years ago little attention was given to this important subject, and if the tools were lucky enough to get any attention it was probably from some handy man passing out drills and taps from the tool room window. The continuous and almost universal use of pneumatic tools today brings up the question not only of repairs, but of economy of operation. Instead of waiting until a motor or hammer is broken down before tagging it for the tool room it should be periodically inspected and repaired, and there should be kept a systematic record of the condition of each tool as well as the cost of its upkeep.

The air consumption of each tool should be studied. No up-to-date shop can afford to keep antiquated tools of obsolete design operating on its floor when it is realized that the cost of air is so great. Even the most modern four-piston air motor consumes from 50 to 60 cu. ft. of air per minute, and when it is considered that through wear or lack of attention it is often consuming 70 or 80 cu. ft., a loss in actual dollars and cents is evident, which will, many times over, pay for the repair parts and labor necessary to place the tool in first class operating condition, or even purchase a new one to replace it.

In order to emphasize the importance of maintenance, attention is called to the fact that on a full load basis for equal periods the cost of the compressed air required to operate an ordinary 35-lb. pneumatic drill used for such work as staybolt tapping, etc., is from two and one-half to three times as great as the cost of electricity to drive an 18-in. engine lathe.

The standard four-piston type air motor has a crank speed varying from 2,000 to 2,500 revolutions per minute, but as this is geared down at the spindle to a speed suitable for the class of work on which it is to be used the casual observer does not realize the amount of action taking place inside the metal casing. However, it is readily seen that with these little air pistons operating at such high speeds it does not require a great amount of false adjustment or wear to soon result in a large increase in air consumption. With the actual cost of air known and knowing the cost of the various repair parts, such as pistons, bushings, valves, etc., it is an easy matter to determine the economic high and low limits for every tool and to establish a system by which repairs are made on a basis of air consumption tests rather than under present practice.

The apparatus necessary for testing air consumption and power developed, covering both pneumatic motors and hammers is inexpensive and can be operated if desired by a second or third year apprentice. Data can be kept in such shape that every tool will have its record on file covering both the tests made and the parts replaced. With such a system in operation, if an air motor, the card record of which shows a normal air consumption of 50 cu. ft. per minute, is sent in for test and is found to have a consumption of 60 cu. ft. per minute, on a basis of three cents per day for each cubic foot per minute, it is wasting 30 cents per day, or $9 per month of 30 days. It will not require much calculating to show that regardless of the service which this tool may be giving it should go to the repair bench.

The same idea applies to the various types of hammers, all of which are at times eating up many times their worth when to outward appearances they are in first class condition. With a hammer, however, the waste is not so great, as it is held in the hand in such a manner that the operator becomes extremely sensitive to its operation and can often tell from "the feel" that it is taking too much air. However, the average shopman has never had impressed upon him the great cost of compressed air and his education in the matter by the methods now utilized in safety promotion work would undoubtedly result in eliminating many wastes.

A FEW FACTS ABOUT INSPECTING BOILERS*

To become a good boiler inspector does not require any especial gifts or qualifications. About all required is the necessary "know-how" and some horse sense, and the more of it the better for both inspector and boiler. The good inspector must know enough about boiler design to tell when a boiler is safe or not under the pressure desired to be carried. He must also be enough of a boiler maker to know when work is well or poorly done, and must be able to recognize errors and omissions in boiler construction as well as in its design.

The boiler inspector must have one faculty well developed, which is born in some people, can be cultivated by others, but which must be part of the mental make-up of every successful boiler inspector. This is the faculty of seeing things—the ability to take one look into a window and then describe more things than you thought possible to be placed in a room, much less a shop window.

Just line up the candidates for a position as boiler inspector, take them one at a time to a window, or a bank of shelves, upon which you have arranged in plain sight one hundred different articles—tools, bolts, nuts, familiar things pertinent to the boiler shop and its surroundings. With one hundred articles in plain sight, bring each candidate in front of the window or cabinet which is covered by doors or by a curtain. Tell each man that you are going to show him the things inside the cabinet for exactly ten seconds, after which he is to name each thing he sees. Draw aside the doors or curtain, give each man ten seconds and then immediately let him name the things he has seen and let a stenographer take down the names he mentions. If you don't have a stenographer handy, let somebody take down the names in long hand. If the man is not unusual, or trained in using his eyes, he won't see so many things that you can't write them all down in a few minutes. Sometimes, as in the case of candidates who are a bit diffident and apt to become confused, just give each man a pad of paper and let him write down the names

*From an article by James Francis, appearing in the June, 1915, number of The Boiler Maker.

himself. He can usually remember more of them when treated in this way.

The inspector's bag should always contain candles. They are not always to be had on the spot. Put in also a light hatchet-pene hammer and a small cold chisel. I always carried in my kit two light but strong steel chains and two small Yale padlocks. Whenever I had to go into one of a battery of boilers, I always made sure that the steam valve and the feed valve which prevented hot water or steam from reaching me from adjacent boilers were so chained and locked that they could not be opened while I was inside the boiler to be inspected. It doesn't do a man's nerves any good to hear a laborer working around the valves which cut his boiler from those under pressure on either side of him.

If there be any defect in a boiler, be sure you find it. That is what boiler inspection is for. It does no good to look into, over and under a steam boiler and not see everything there is to be seen. And here is where the training of looking at the articles in a window or cabinet comes into play, for the man who sees the most things in the cabinet can see the most things about a boiler, and, be these things good or bad, it is the inspector's business to see all of them.

"Whenever you see a head, hit it," is the only safe rule. Take absolutely nothing for granted. See everything and see just what condition everything is in. Perhaps you have gone all over a boiler and have found nothing wrong and you are at the front end, inside, with your head poked in among the braces, looking after the fastenings of the braces to the shell. Perhaps you have examined and sounded all the braces but one, and to get at this one you have to back out from your position among the braces, work your way around to the other side of the boiler and worm yourself in among the tubes again on that side of the boiler. In a case of this kind the temptation is very great to say: "There's nothing wrong with that brace—no use bothering to look at that one, for I have looked at every other brace in the boiler and they are all O. K.; probably that one is all right too, so I won't bother to crawl in and look at it." Don't you ever do such a thing, for if you do so you will be no good as a boiler inspector and might as well quit the business. There is a possibility that the brace you don't look at may be defective.

To emphasize the necessity for being always on the lookout and never slighting even the smallest thing in a boiler I want to tell about one thing that happened to me which led me to do more hammering and more poking around in corners where I couldn't see very well, and where there *might* be corrosion or cracks or deposit or some other weakening action going on in its hidden way. I had been all through, inside and outside, of a large return tubular boiler and had found nothing wrong, but intended to report adversely regarding the covering of the boiler, which was of brick, laid in arched form over the top of the boiler—a very bad arrangement, largely in use in cold latitudes several years ago, but happily seldom seen now. I was inside the boiler, had looked at both heads and had worked my way back to the manhole, in readiness to come out of the boiler. From some cause or other, not clear to me even now, I rolled over on my back and laid there a few seconds, looking around at everything I could see, and apparently everything was in good shape. I was just going to swing myself up into the manhole when a streak on the boiler shell about 2 ft. from the manhole happened to catch my eye, and from force of habit, I struck the spot with my hammer. I did not like the ring from that blow and struck the shell many times around and in that streak of rust; then I got out of the boiler, located the spot on top and tore off a section of the brick covering and laid bare the shell. I did more hammering there and dislodged a great mass of rust and corrosion where water from a leaky pipe overhead had been seeping down through the brick work upon the boiler shell for several years. When the boiler was shut down there was no water in the pipe and no leakage, hence no inspector had caught the fact.

After digging and hammering all the rust away the shell at the rusted place was found so very thin that a well-directed blow from the pene of the hammer went through the shell.

In the course of many inspections, I have found quite a number of defects which would have slipped past me had I ever taken anything for granted.

But as greatly as I was surprised over the boiler in question, my company was even more surprised a short time afterwards when they received a bill for repairs from the owner of the boiler in question. The bill was accompanied by a very short letter, requesting immediate settlement of the bill, and stating that it was sent to the insurance and inspection company for the reason that *their inspector broke the boiler!*

SYSTEMATIC VALVE SETTING ON LOCOMOTIVES*

BY J. R. BRITTON
Schedule Inspector, Angus Shops, Canadian Pacific, Montreal, Que.

Locomotive valve setters in the past have been left very much to their own resources, thus allowing various methods of valve setting with more or less difference in the results obtained. Systematic valve setting, when commonly understood and agreed upon, would insure definite methods which would be definitely stated to cover each design of valve gear on the various classes of engines, in order to develop maximum power and speed when working in the running reverse gear position. It would include an information sheet for the valve setters, containing lead specifications and other necessary points to be observed during valve setting. Some time ago a step was made in this direction by issuing information sheets giving specified full gear lead for the various classes of engines in the Canadian Pacific Angus Shops. The system recommended is to carry this still further, covering definitely all other necessary details relating to valve setting and establishing a common practice to be observed by all. This would be supplemented by a printed work report, which would be in itself a fair guide to the uninformed. This would be filled in by the man setting the valves and would render a statement of the various points necessary for accurate valve setting, showing that they had been properly observed. Lead and full gear port openings would be noted on the work report, thereby exposing any deviation from specifications immediately, which could be taken care of before the engine left for an outside point.

Valve setting is the most important work in connection with the construction or repair of a locomotive. In the past the tendency has been to set the valves on all classes of locomotives, *i. e.*, freight, switch and passenger engines more or less alike, but this system would allow of a definite valve setting to suit the conditions under which each class of engine works.

When a locomotive is taken into a shop for general repairs its motion is carefully inspected and all worn parts requiring repairs are taken care of by the machine shop. After this it is returned to the erecting shop, where it is re-assembled and put up, either by the man who is to set the valves or under his supervision. Under the system suggested all parts would have to comply with the standard instructions and in addition to this the valve setter would be expected to check the location and lengths of parts of the valve gear, particularly the reverse shafts, reverse shaft arms and in the case of Walschaert gear, combination levers, union links, radius rods, etc. No deviation from the first setting of eccentric crank arms or eccentrics would be necessary. After the valves are set the cut-offs are generally taken in order to prove the work. This time would be saved in many cases. Another advantage of such a system would be the establishment of a general understanding, which would eliminate the cost of further re-adjustments at outside points, owing to the difference of opinion.

*From a paper read before the Canadian Railway Club, April 13, 1915.

WELDING COPPER AND COPPER ALLOYS BY ACETYLENE METHODS

BY J. F. SPRINGER

Theoretically, the oxy-acetylene process of welding is applicable to all metals. The heat supplied is ample to fuse any of the metals, including even platinum. Practically, however, it has been found necessary to limit the process. There are so many matters that have to be cared for that it is no wonder that the commercial practice of a few years has not caught up with theory. Aluminum welding presented difficulties. These have been pretty well removed, so that today aluminum may be welded with almost, if not quite as much certainty as steel. Copper welding has proved more difficult still; and it has only been for a very moderate length of time that it could be done, even by a few operators, with commercial success. The difficulties have now been pretty well overcome.

It is the purpose of this article to set forth briefly the main lines of the practical advance. The reader is cautioned, however, not to consider himself a copper welder as soon as he has finished reading this account. In order to attain proficiency and certainty, he should go through a period of actually trying out his newly acquired knowledge upon work of little or no value. The present article may be regarded as a guide that points out the main matters, showing the acetylene welder along which lines success is to be expected.

While copper is the metal specifically treated in this article, the directions should be regarded as having greater or less application to its multitudinous alloys. Rolled commercial copper has a specific gravity of about 8.9. Copper in other forms will not vary greatly from this in its specific gravity. It is, accordingly, distinctly heavier than iron or steel. Its specific heat is 0.094; that of steel is 0.118. Accordingly, a less quantity of heat (20 per cent less) is required to raise the temperature of copper than is the case when dealing with steel. The temperature of fusion of copper is about 1,982 deg., Fahrenheit; that of steel is, say, 2,500. Copper is, consequently, not only easier to heat up, but the terminal point is very much lower.

In practical operations with the gas torch, the ease of raising the temperature to the welding point is more or less offset by the excessively high heat conductivity of copper. With the thermal conductivity of silver taken as a standard, those of copper and steel are, respectively, 73.6 and 11.6 per cent of that of silver. The parts of the copper work adjacent to the immediate region of welding carry off the heat more than six times as fast as would be the case if the metal were steel.

Taking all the foregoing facts into consideration, there is perhaps not much difference with copper work in the amount of heat that has to be poured into the joint than with steel work. Consider, however, other matters. The swift conduction of heat operates to create a wide zone of highly heated metal on either side of the joint. While the temperatures of these zones may be lower than those of similar zones in steel welding, still the fact remains that they are high relatively to the fusion point of copper, and this is what is important. The sluggish conductivity of steel enables local heating to be done without involving more than a narrow region on either side; the rapid conductivity of copper spreads the high temperatures to considerable distances.

The coefficient of expansion and contraction is for copper much higher than for steel. The result is that the contraction in the copper weld will go on more rapidly as cooling takes place subsequent to welding. The total amount of contraction is probably less than for steel, because of the much lower temperature of fusion; so that this is not the thing to watch, but the rate of contraction.

The wide zones of highly heated copper introduce a considerable difficulty, perhaps the greatest of all. Copper has the property of absorbing considerable quantities of oxygen from the atmosphere. The effect is to reduce the melting point for the affected parts. Further, when just below its fusion temperature, copper passes into a condition of such a character that mechanical operations upon the metal tend to reduce it to a powder. If tensile strains occur while the copper work passes through the dangerous temperature zone, then cracks are to be expected.

In order to prevent burning of the metal through exposure to the air, it is advisable to protect in some way the regions to either side of the joint. One method of doing this is to provide a tough coating over the regions which may suffer exposure. Another is to supply through the welding rod some material which will spread over the work and nullify by its oxidizing power the effects of the oxygen in the atmosphere. But we must go further back than this. The very flame which supplies the heat is fed by a mixture of oxygen and a fuel gas. If there is an excess of oxygen in this mixture, we must expect this excess to operate against the copper itself. It is advisable, then, that the adjustment of the torch shall provide for a deficiency of oxygen, or, what is the same thing, for an excess of the fuel gas. In oxy-acetylene welding, the small, inner flame is a notable feature. For steel welding, this flame is white and is surrounded by a deep-blue, transparent enveloping flame. It is supposed that the inner flame, from a point just beyond the exit to the tip, or nearly to the tip, consists of carbon, hydrogen and oxygen in an uncombined state. The carbon and hydrogen are the products of the disintegration of the acetylene. Evidently, then, the copper work should not be exposed to the free oxygen in this inner flame. The condition of the flames corresponding to an excess of acetylene is indicated by the little inner flame becoming less sharply defined and assuming a yellowish color. This is the condition sought for copper welding. It is well to be familiar with the condition of the flames when the dangerous (for copper work) excess of oxygen occurs. This may be noted by the diminished size of the inner flame and the appearance of a violet color.

It is considered good to add a small amount of aluminum when welding copper. This aluminum may be added to the welding rod, and its percentage should not be more than 0.01. It is said to produce about the same effect as does aluminum when added to molten steel. It seems to act as a scavenger, gathering to itself the impurities in the pool of molten metal at the welding point. Since aluminum is itself very light, it will rise quickly to the surface.

The welding rod may advantageously contain a de-oxidizing material, such as phosphorus. It is claimed, however, that, if the de-oxidizing materials be other than phosphorus, then the introduction of phosphorus through the flame may result injuriously.

In the process of welding, more or less of the protoxide of copper will be formed. This will occur, in part at least, in the form of an alloy with metallic copper. It is necessary to get rid of it. Further, the de-oxidizing materials used in the welding rod will form combinations with oxygen. These must also be eliminated. A list of de-oxidizing materials follows: Tin, zinc, nickel, iron, manganese, phosphorus, silicon, aluminum, magnesium. These are given in the order of their activity, the latter ones having the greater activities.

In order to protect the heated surfaces to either side of the joint from the injurious effects of the atmosphere, a special powder may be employed. The powder may be spread over the surfaces in the form of a paste before beginning welding. The mode of operation of some of these powders is as follows. The heating of the metal results in melting the powder and the formation of a skin which covers the metallic surface and thus shuts out the oxygen of the air. Here a lesson may be taken from the art of hard-soldering. Borax is employed for just about the same reasons as obtain in welding. The borax must not be used in its commercial form, but must first be cleared of its water of crystallization; otherwise, the water is liable to decomposition into its elements, whereupon we have free oxygen. Instead of borax, certain silicates may be used. Powdered glass, pulverized gravel or clay may be employed. However, we may

add to our powder ingredients which actively shield against oxygen by their avidity for it. A preparation of sodium, phosphorus, boron or magnesium is suited for this purpose. Pulverized wood charcoal may also be added. In compounding a welding powder, the rule should be observed to include no substance whose specific gravity is greater than that of the metal in the molten weld, otherwise, they can not be depended upon to rise to the surface and are pretty sure to become entangled in the material of the weld. In order to make the welding powder into a paste, either water or alcohol may be used. In this case, the water will not have the injurious effect which is to be expected from the water of crystallization. It will here be quickly evaporated instead of being decomposed into its elements.

It is considered important that the pulverization of the component substances in the welding powder shall be carried pretty far. The grains should in size approximate particles of dust. With rather large grains there is the possibility of vaporization or fusion of one before another; while, if the finely powdered condition obtains, the behavior is similar to that of an alloy. The average melting point for the powder must be below the melting point of the copper; and the vaporization point of the powder must at least equal the melting point of the metal. That is to say, the powder must melt but not vaporize during the welding operations.

In copper welding, the acetylene process is to be regarded as superior to the hydrogen procedure. Perhaps this remark should be made much stronger. Sufficient reasons for preferring the oxy-acetylene system consist, (1) in the avidity with which molten copper absorbs hydrogen gas, and (2) in the fact that one of the final products of the oxy-acetylene torch is carbon dioxide. This gas has the property of freeing copper of absorbed hydrogen. The importance of a clear understanding of this matter will justify a brief outline of the probable chemical reactions. In the case of the oxy-hydrogen torch, a mixture of oxygen and hydrogen issues from the tip; the oxygen combines with hydrogen and water vapor results. However, in practice, it is found necessary to supply hydrogen in an amount exceeding that required by the oxygen. No doubt it is this excess hydrogen whose burning by means of the oxygen of the air causes the existence of the enormous flame. The oxy-acetylene flame may be divided into three parts. The bright innermost flame is understood to contain oxygen, carbon and hydrogen in an uncombined form. Surrounding this bright innermost flame is a kind of envelope in which it is understood that the hydrogen remains as it is and the carbon is burnt to carbon monoxide. Finally, there is the large exterior enveloping flame where the hydrogen is supposed to be burnt to water vapor and the carbon monoxide to the dioxide. Now, even with the oxy-acetylene flame there is, accordingly, free hydrogen in contact with the copper. However, there are two considerations which enter here: the amount of hydrogen is only 7.7 per cent of the total weight of the acetylene; carbon dioxide is formed in considerable quantity, and has the before-mentioned property of eliminating hydrogen from the copper.

Another advantage of the oxy-acetylene procedure is cited by a writer in Autogene Metallbearbeitung. This relates to the protective activities of the outermost flame. As the mixture of gases coming from the tip, even when the torch is used normally, supplies only a slight excess of oxygen above that necessary for the burning of the carbon to carbon monoxide, the bulk of the oxygen needed to burn the hydrogen and the carbon monoxide is derived from the atmosphere. In other words, the outermost flame is an active, de-oxidizing agent, robbing the air of its power of injuring the copper. The oxy-hydrogen flame is doubtless to be preferred when the cutting of steel is in question; but with copper welding, the oxy-acetylene process is certainly to be preferred. The respective fields of activity differ at these points.

The careful reader will, in the light of the foregoing facts and explanations, perceive sufficient reasons for certain rules of procedure. In copper welding, the torch is held vertically and not obliquely. The effect sought is to divide the outermost flame into two wide-spreading tongues covering the work on either side of the joint in an extensive manner. We are thus protecting the highly-heated adjacent metal from the oxygen of the air. This procedure may at times even be sufficiently effective of itself to warrant us in dispensing with the welding powder. In such cases, it is recommended that the welding rod be of pure, electrolytic copper.

If the work consists of thin copper plates whose thickness does not exceed ⅛ in., their edges may be joined without the use of a welding rod. The edges should be bent up so as to project above the surface an amount equal, say, to the thickness of the sheet. The two bent-up edges are placed together, and the torch operated vertically and in such a manner as to melt down the double ridge. In order to protect the work on either side, welding powder in the form of paste may be applied. The portion painted should be perhaps an inch broad on either sheet of metal. The powder should be applied also to the summit of the double ridge. Care should be exercised not to use too much paste or powder.

Copper welding requires promptness in execution. If the welder lingers too long, the powder or paste will be exhausted and the oxygen of the air may have opportunity of attacking the work. If the welding rod supplies de-oxidation material, this material too may become exhausted by delay. If a piece of welding has once been done and it becomes desirable to go over it again, fresh powder or paste may well be applied before begginning. Accordingly, the welder should not return to a point once passed without giving attention to this matter.

It has already been pointed out that copper is a very rapid conductor of heat. The welder should bear in mind that this conduction will operate downwards as well as to right and left. It is advisable, therefore to arrange beneath the region of the zone of operations a heavy sheet of asbestos or similar material. It is recommended that before beginning actual welding this asbestos sheet should be heated by the torch along the region of the future weld; the object is in part to drive out any contained moisture. Following this application of heat, welding powder or paste should be applied to the asbestos, thus guarding the work on the under side. The presence of the asbestos beneath the joint has also the advantageous effect of assisting in preventing a dissipation of the heat and consequently in facilitating the welding.

If the work consists of thick copper plates—plates having a thickness in excess, say, of ⅛ in.—then the opposing edges may be beveled just as is done with iron and steel welding. A welding rod will be ordinarily employed in these cases; asbestos may advantageously be used beneath. Also, it will probably assist in most cases, if asbestos sheets are laid upon the work to either side of the path along which the torch is to operate. Indeed, in some cases, such protection against loss of heat may be imperative, because otherwise the heat might be carried off with nearly as much rapidity by the work as it is applied by the torch.

Copper welding requires a sure hand; quickness without hurry will often be demanded. At times, it will be necessary to move along the seam with increased rapidity. This necessity may become so urgent that difficulty is experienced in getting the welding rod to melt rapidly enough. It is advisable, in order to be ready for this situation, to use a welding rod whose diameter is considerably less than the thickness of the copper sheets of the work. An idea of the proper rapidity of conducting the work may be gained from the accompanying table of acetylene consumption.

Thickness of copper plate, in inches	Acetylene consumption per hour, in cubic feet
0.08	7
0.12	11¼
2.00	21
3.20	35

It is pertinent to call attention to the fact that the impurity of the oxygen used affects the temperature of the flame. With pure oxygen a temperature of 7,200 deg. Fahrenheit seems attainable; but if the oxygen is only 95 per cent pure, the impurity being

assumed to be nitrogen, then the temperature will drop to, say, 5,400 deg. This temperature is sufficiently high to effect fusion, but the loss is felt in the increased difficulty to pour into the work a sufficient amount of heat. Where oxygen is prepared by electrolytic means, the impurity will probably be hydrogen gas, itself a fuel. Apparently, then, such oxygen is to be preferred to that obtained by the liquefaction of the air.

To recapitulate certain main points; copper welding must be done with a torch adjustment providing for acetylene in excess of the amount used in steel welding. Care should be taken not to permit the innermost flame to touch the metal. The torch is to be managed vertically in such a way as to throw a branch flame to either side of the joint. The work must proceed uniformly and with considerable rapidity. If no de-oxidation powder or paste is employed, it is advisable to use electrolytic copper for the welding rod. Under all conditions where a rod is employed, its diameter should be distinctly less than the thickness of the work. Thin sheets may be welded without a rod by melting down turned-up edges; in this case, the welding powder or paste should be applied not only to either side of the joint, but also upon the double ridge formed by the turned-up edges. In copper welding, asbestos may advantageously be used beneath the region of the joint and also on top at a short distance to either side of the joint; the asbestos beneath may profitably be heated in advance and treated with welding powder or paste. A de-oxidizing powder or paste may usually be used to advantage. De-oxidizing and purifying materials may be employed as ingredients of the welding rod. An oxygen free from any considerable percentage of nitrogen should be preferably employed. Acetylene rather than hydrogen is preferable for use in the torch used in copper welding.

APPRENTICE SCHOOL CAR

The photograph reproduced below is believed to show the first apprentice school of its kind. The school-room occupies a passenger coach which has been fitted up specially for the purpose with drawing tables, blackboards, etc. The school is conducted jointly by the Staten Island Line of the Baltimore & Ohio and

Interior of Staten Island Apprentice School Car

the Board of Education of the City of New York. The Board pays the salary of the teachers, who in this case are employees of the railroad, and also pays for the material used. Apprentices are allowed pay for one-half time while in school. Drawing is being taught by Harry Lawrence, shop draftsman, and mathematics by J. W. Rissik, special apprentice. The school was started in the fall of 1914.

CAUSE OF HIGH SPEED STEEL TOOL FAILURES

BY GEORGE J. BRUNELLE

Among the petty troubles of the modern shop manager there are none perhaps more annoying than the frequent failure of high speed tools. Once a shop has been supplied with a brand of steel advertised to "take heavy cuts at high speed" no further trouble is anticipated; yet tool failures occur frequently, and with toolsmith and machinist denying their responsibility, the causes are hard to trace. Literature on the subject is scant. Authorities write volumes on carbon steels, but about high speed steels they are strangely reticent. Consequently, it devolves upon the man interested (the toolsmith) to find out for himself, by sly experiment and surreptitious visit to the machine shop, the causes of tool failures.

Nearly every failure is laid at the door of the toolsmith. The usual way is to return the tool to him with instructions to "try it again." For some reason the machinist's judgment is seldom questioned. Whatever the reason, it does not seem good, because with a machinist tools are an incidental, while with a toolsmith they are a specialty, and ours is a day of specialists and experts. Now a good toolsmith is an expert. He should know approximately the possibilities and limits of each tool, the use to which it is to be put, and should have, besides, a general knowledge of every machine on which forged tools are used. Constant study of everyday problems arising from tool failures cultivate his judgment so that he is seldom in error in placing their cause.

Properly speaking, high speed steel is not a pure metal. It is known as an alloy or mixture of metals. Each brand has a different formula and the elements in them vary in number from 15 to 20. It cannot be welded and differs from carbon steel in that it retains its density and hardness at high temperatures. It cannot be hardened as hard, nor annealed as soft, as carbon steel. Roughly speaking each one of those 15 or 20 elements affect the quality or properties of the steel. Some give hardness at the expense of toughness and others vice versa. Thus of the different makes (and there are sometimes a dozen or more in a shop) some are hard and brittle, while others are not so hard but tougher, making them more reliable where delicacy of form is necessary.

It is a common error to conduct a "test" of different brands of steel by using them for the same kind of tool on the same kind of work in the same machine. The form commonly used is a tool of strong section, and this is generally used at high speed and heavy cut in the hardest material at hand.

Now the very properties that make a steel highly efficient under these conditions are usually the cause of its failure when made into a tool of delicate shape, and used in ordinary material. A test is not thorough unless it meets ordinary conditions. This is proved by everyday experience, and by the fact that the same steel is not always the winner in different shops. Good authorities hold that there is no brand that can fulfill both requirements—great hardness and great toughness, selling agents to the contrary notwithstanding. Yet when a toolsmith is given a piece of steel to make a tool, he must get maximum results or the management threatens to get another toolsmith.

Assuming that a steel is at hand that serves general purposes fairly well, there are several causes that will make it fall below its general standard. Chargeable to the toolsmith are:

FORGING	HEAT-TREATING
1—Heating too fast.	5—Over-heating.
2—Not heating uniformly.	6—Kept at high temparature too long.
3—Over-heating.	7—Not heated enough to get maximum high speed properties.
4—Forging too cold.	

Thus we find seven possibe faults in a properly shaped tool,

each of which will impair its usefulness. Now for purposes of comparison let us consider a tool to have avoided these and enumerate some other faults that would prevent its coming up to its standard:

Due to Grinding

Cause	*Effect*
Too fast on dry wheel	Soft edge
Too fast on wet wheel	Cracks
Not ground enough	No edge
Too much clearance	Crumbles
Too much rake	Breaks
Too much shear	Breaks
Ground to negative rake	Breaks
Not enough shear	Cuts rough and seems dull

Due to Abuse

Cause	*Effect*
Too much overhang	Tool chatters
Material not annealed	Tool seems soft
Too much speed	Tool seems soft
Chip too large	Tool breaks
Chip too small	Tool not under scale
	Tool seems soft
Gritty material	Tool edge grinds off

On summing up we find that the chances of the tool being spoiled in grinding are even and when in use these are two to one against the machinist.

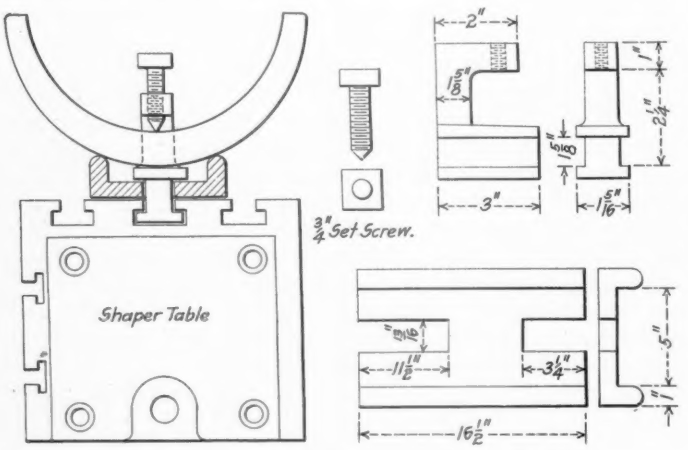
And there are yet other causes not chargeable to either smith or machinist that may nullify their best efforts toward producing a good tool. The steel may be incapable, at its best, of sustaining its edge at the required speed, perhaps a cheap steel or one intended for tools of delicate shape, where toughness is a primary consideration. It may also have been forged in a coal fire that had an excess of sulphur and phosphorous, both deadly poisons to steel, or a furnace of "home make" where the heat is forced through the steel from one side. Last, and by no means the most uncommon, is a wet air blast, which is sure to cause a tool to "flake off the top."

It is evident, then, that the placing of the blame for tool failures is a matter requiring much experience and good judgment. They should be carefully inquired into and corrected, for with high speed steel costing from 45 to 85 cents per pound, it would seem worth while that not only the selection and forging be done carefully and economically, but that some one should see to it that the user of the tool grinds it right and when it is sharp that he stops grinding.

JIG FOR SETTING UP CROWN BRASSES IN THE SHAPER

BY LOUIS LEBOVITZ

A simple jig is shown in the drawing which facilitates the clamping of driving box brasses to the shaper table for finishing the corners. It may also be used on a bench or a surface



Jig for Holding Crown Brasses on the Shaper

plate provided with tee slots, to hold the brass while chipping.

The channel plate rests on the shaper table and is provided with slots in the ends. The bases of the clamps are inserted into a tee slot in the table, and when the brass is in place the clamps are slid into the slots in the channel plates and the whole rigidly secured to the table by tightening the set screws.

TRAINING OFFICIAL MATERIAL AND JOURNEYMAN APPRENTICES*

BY F. H. THOMAS

Supervisor of Apprentices, Atchison, Topeka & Santa Fe, Topeka, Kan.

Seven years ago the Santa Fe System was greatly crippled on account of the difficulty in getting efficient mechanics. There were not enough to go around. The throttling effect of the labor organizations in limiting the number of apprentices, had practically driven the apprentice system from the shops and country, and had reduced the supply of mechanics way below the demand. The railway company inaugurated its present system of educating and training its own men. The scheme was successful from the start; we are getting the best boys of the community, and are rapidly filling our shops and offices and stations with the best class of men in the country, energetic, ambitious, honest, and loyal. We select boys whom we deem fitted for their chosen work, exercising a great deal of care.

We have now turned our heads toward a method of selecting official material from this young army. The management has said we must promote our own men and not go outside for officers. Such being our orders, how can we make the selections? We employ a number of college men each year, calling them "special apprentices." The college man is generally chuck full of learning, but distressingly lacking in horse sense or application. So we have been called upon to establish a special course or plan for developing official timber. We select a limited number of graduates of the best technical or engineering schools, and the same number from the ranks of our regular journeyman apprentices who are just finishing their apprenticeship, and require them to pursue a well defined course of training. We require the college man to work one year on machines, another year on the floor, bench, or erecting work. The journeyman apprentice who has been selected for the course, has already served three and one-half years in the above branches. We then require him to work four months in the roundhouse, the real mechanical heart of the operating department of a railroad system. Then he goes in the boiler shop for two months; then in the freight-car shop for two months; then assisting road foreman of engines for two months; finally finishing the year as inspector of incoming and outgoing engines at shop and terminals. During each of these periods he is provided with a course of reading and study and required to write a letter every thirty days, giving a detailed account of the work he has performed, observations, suggestions, etc. His letters are criticized by the supervisor of apprentices and pointed suggestions are made to him. He is urged to select some officer whom all recognize as a successful one, and closely observe his method of conducting the duty of the office, especially observing his method of handling men. This latter phase is the most difficult; good managers of men are few. Every movement of the young man is closely observed. If he falls down in any branch of the course he must pursue it over again. If he fails to develop along the desired line he is put back at his trade. If he fails under fire or at any critical moment, he is corrected and his weakness pointed out. At the first act of disobedience or semblance of insubordination, "off comes his head."

Selections of men for this course are not made in a day, but are the fruit of two or three years of observation and study. Favoritism and pull will not count for much in the selection of the future Santa Fe officers. The reward will be to those of real merit, who have been specifically trained for the place.

*From an address delivered before the convention of the National Association of Corporation Schools, held at Worcester, Mass., June 8 to 11, 1915.

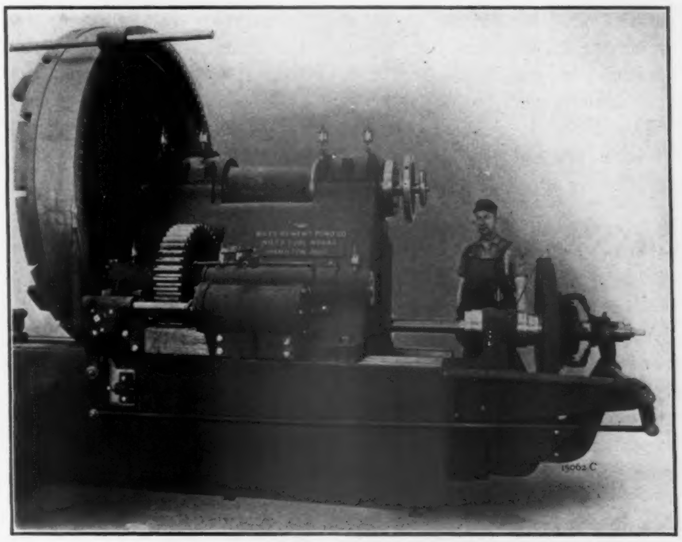
NEW DEVICES

DRIVING WHEEL LATHE

A 90-in. driving wheel lathe, in the design of which are embodied several features of interest, has been placed on the market by the Niles-Bement-Pond Company, New York. It is considerably heavier than any previously brought out by them.

A feature of considerable importance in the operation of this machine is the pneumatic clamping device for the right-hand headstock. This is operated by a large air cylinder controlled by a conveniently located valve, the power from which is transmitted through a rack and worm device to the clamp which secures the head to the bed at both the front and back simultaneously. This headstock is also equipped with a power traverse operated by a separate motor which is placed within the bed to save floor space. The motor is connected to a screw through a friction clutch which is controlled by a lever located so that the operator may traverse the headstock without leaving his position near the tool post. The clutch is so adjusted that it will slip when excessive power is applied, thus eliminating the possibility of damage to the machine in case the face plate should be brought too forcibly against the wheel. The motor is readily accessible for inspection and repairs.

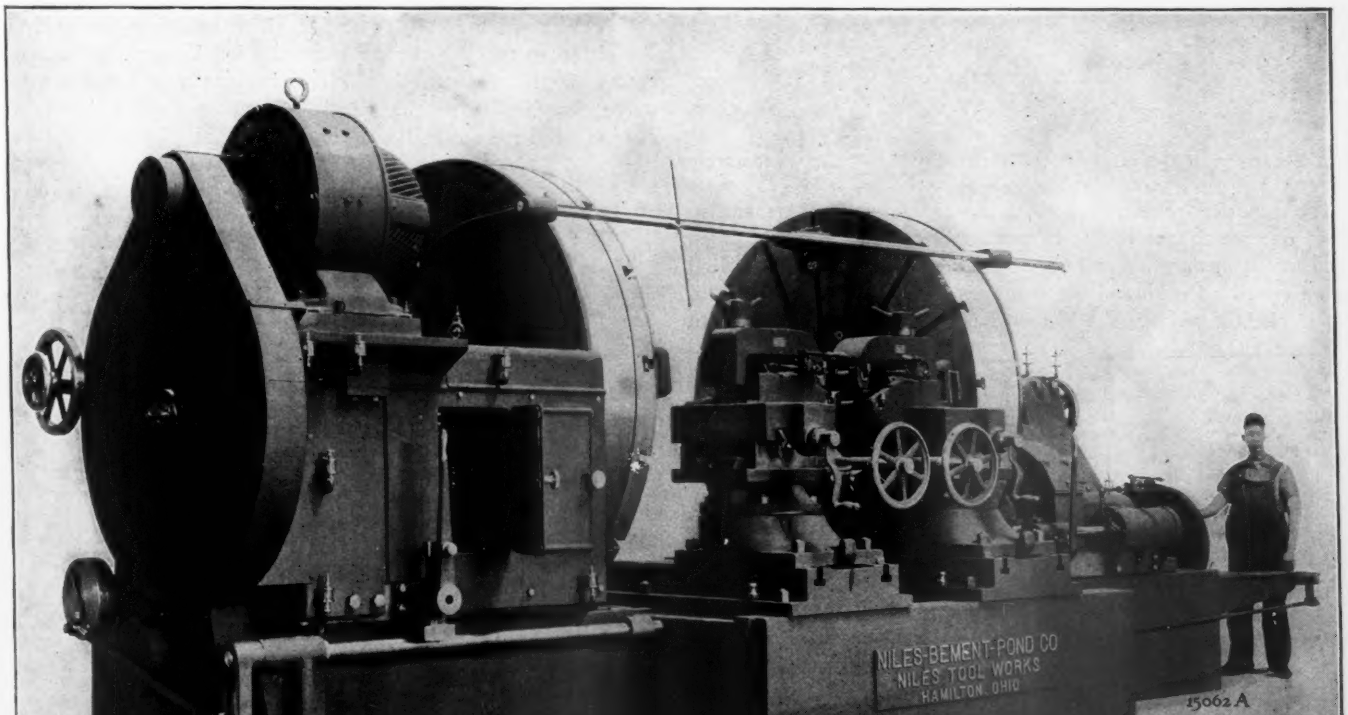
The face plate gears are of the internal type and are driven by pinions located at the front of the machine. The pinions are placed approximately on a line with the tools, thus tending to counteract the strain from the tool and to relieve the main spindle bearing of considerable pressure. All gearing on the lathe is enclosed. The internal gears attached to the face plate are provided with guards at their sides to protect them from chips and dirt, and the driving and speed change gears are enclosed within the left-hand headstock. Doors through the front



Mechanism for Traversing and Clamping the Head Stock

of the headstock provide access for inspecting the mechanism.

Pneumatic tool clamps of a type similar to those included in



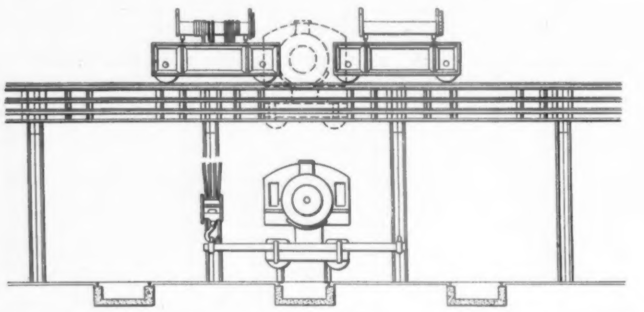
Heavy Model 90-In. Driving Wheel Lathe

previous models are used on this machine. They enable the operator to change and clamp tools in a few seconds without the use of a wrench, and are so designed that the tools are positively locked independently of the air pressure. The lathe is equipped with a calipering device to enable the operator to readily finish both wheels to the same diameter. This consists of an adjustable pointer supported by a bar rigidly attached to the left-hand headstock and having a sliding bearing in its right-hand bracket. The equipment also includes push-button control for direct current motors. Two push-button switches are suspended near the cutting tools, one for starting and stopping the motor, and the other for reducing the speed. This enables the operator to readily control the cutting speed when hard spots are encountered.

The lathe is designed to take axles with outside journals. The centers may be drawn back into the head stocks for this purpose by means of hand wheels on the ends of the spindles.

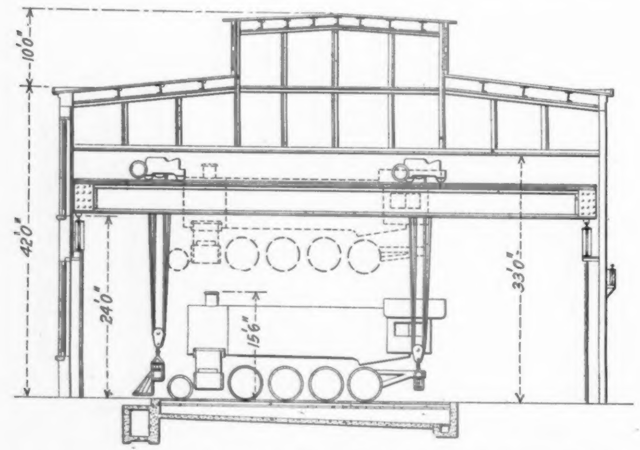
CRANE ARRANGEMENT FOR LOCOMOTIVE SHOPS

A traveling crane arrangement permitting a reduction in head room in locomotive erecting shops of the cross-stall type has been designed and patented by H. Shoemaker, mechanical superintendent, Bangor & Aroostook, Derby, Me. Two parallel cranes are used in lifting the locomotive, the spacing being so arranged as to permit the locomotive to be raised between them.



End Elevation of Cranes Showing Method of Lifting a Locomotive

The practice usually followed in transferring a locomotive from one pit to another is to use one crane with two trolleys, each trolley lifting one end of the engine. The rear end is lifted by an equalized yoke and the front end by a sling placed around the smokebox. When the locomotive is lifted from the floor to



Cross-Section of Erecting Shop with Reduced Head Room

a height sufficient to clear other locomotives standing on the floor it must still be considerably below the bottom of the crane. This usually requires a clear height under the roof trusses of not less than 48 ft., and the height at which the crane is carried requires structural work of heavy design. Owing to the limited wheel-base of a single crane the entire load is lifted and carried by one pair of track girders.

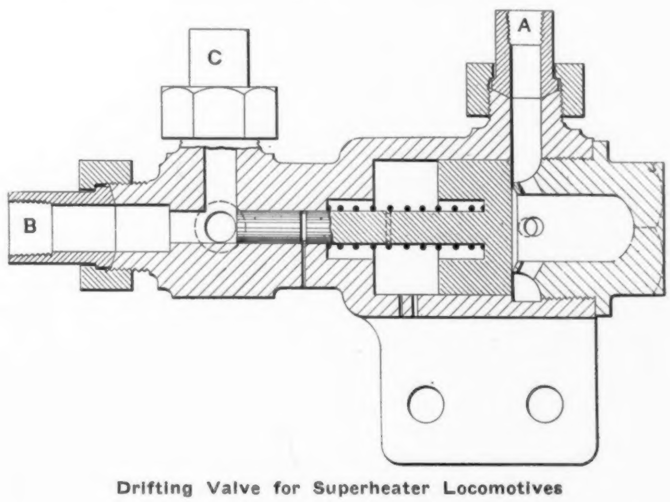
The new arrangement consists of two connected traveling cranes adapted to traverse the runway coincidently and separated by a space sufficiently wide to clear a locomotive when hoisted between them. Hoisting yokes equal in length to the distance between the center lines of the two cranes are placed under both the front and rear ends of the locomotive, the hoisting being accomplished by four trolleys, two on each crane.

Several advantages are claimed for this arrangement. Owing to the reduced head room required the height of the building may be made approximately 15 ft. less. A similar reduction in the height at which the crane is carried is also effected. This lowers the cost of the building and considerably lightens the structural work required to carry the cranes. Shorter and lighter columns may be used and the track girders may be made lighter because of the distribution of the load over a much longer wheel-base. The length of wheel-base is sufficient to distribute the load over three girder sections when lifting an engine; in no position will it be concentrated on one section.

AUTOMATIC DRIFTING VALVE

An automatic drifting valve for use on superheater locomotives is shown herewith. It is known as Wood's vacuum breaker and its operation is controlled by the pressure in the live steam passage of the valve chamber.

The device has four pipe connections: Pipe *A* leads to the live steam passage of one of the valve chambers or to one of the steam pipes; pipe *B* to the turret, or other source of constant boiler pressure, and the two pipes *C* to the live steam passages of the valve chambers. When the throttle is open the plug piston in the large chamber at the end of the valve body is subjected to the pressure in the valve chamber. The resulting movement of the piston to the left closes communication between the constant steam supply at connection *B* and the passages leading to the valve chambers. On the release of pressure at *A* due to the closing of the throttle the spring forces the piston back to the



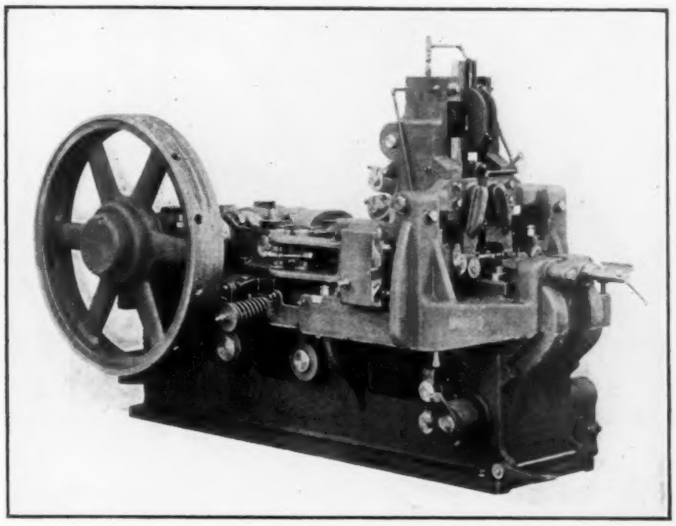
Drifting Valve for Superheater Locomotives

right, opening the communication between connection *B* and passages *C* and admitting a limited supply of steam to the valve chambers, which provides a medium for carrying and distributing the lubricant over the valve chamber and cylinder walls.

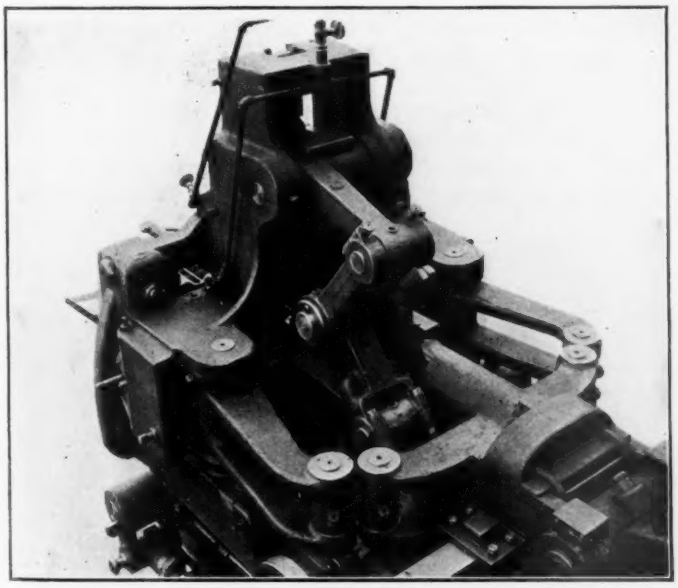
A patent has been applied for on this device and it is manufactured by the Nathan Manufacturing Company, New York. It has been subjected to service trials and its performance is understood to have been highly satisfactory. It may be located at any convenient point on the locomotive, preferably near one of the cylinders.

CONTINUOUS MOTION HAMMER BOLT HEADING MACHINE

More than half of all square, hexagon and tee head bolts are the product of the hammer type of bolt heading machine. In the operation of the usual design of these machines the output, both in quantity and uniformity, is dependent entirely upon the physical ability of the operator and the care exercised by him. The labor involved in operating the machine is considerable, the movements of gripping, starting and stopping the machine for each blank introduced and each bolt completed, being performed by means of hand levers. These movements induce fatigue, and as the fatigue increases, the efficiency of the man and machine decrease. The number of blows used in making a bolt also depended entirely upon the watchfulness of the operator, and it is common, where the operator's attention is lax, to find bolts of supposedly one quality and finish varying greatly, due to the lack of uniformity in the number of blows received.



Continuous Motion Semi-Automatic Hammer Bolt Header



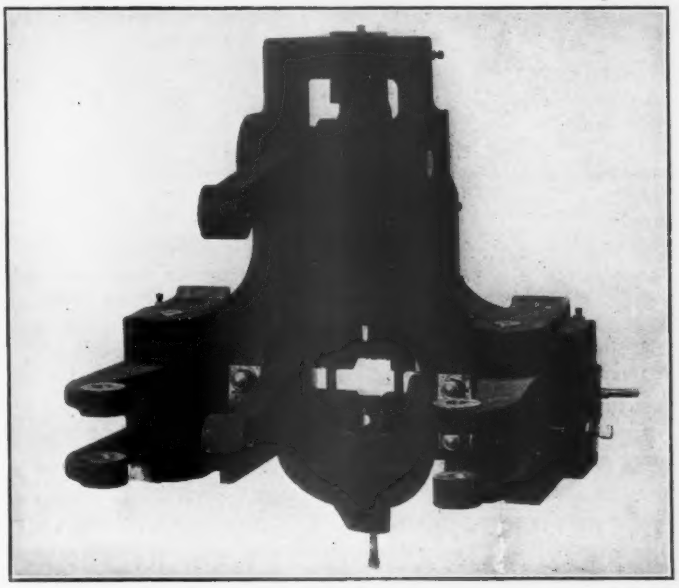
Link Motion for Operating the Hammer Levers

A new hammer heading machine has recently been developed by the National Machinery Company, Tiffin, Ohio, in the operation of which the manual labor has been considerably reduced. The gripping, starting and stopping movements are effected automatically, and the operator's entire attention and energy may be devoted to feeding the machine. The main shaft, heading slide and the hammer slides of the machine run continuously as in a rivet header so that the machine in a measure sets the pace for the operator.

A feature of the design is the ability to set or time the machine to deliver any predetermined number within a range of three to eight blows in each cycle or operation. The machine thus set, the finish of the output is necessarily uniform. The length of time that the grips are open for feeding can be regulated to suit the needs or ability of the operator and according to the length or type of bolt being made. These changes are effected through a simple gear and cam device.

The bed of this machine is of the box type, of large proportions, and is constructed to secure rigidity as well as strength. Owing to its greater rigidity a four-blow bolt made in this machine is said to be equal to a five or six-blow bolt produced in machines of the usual design. The bolt being made in less blows and less time, there is a better flow of the metal to fill out the corners. It is also possible to work the metal at lower heats, reducing the tendency of the metal to bulge at the top and sides of the bolt head.

Another departure in this design is the lever construction for carrying the lower hammer. This is usually carried in a slide the same as the side and top hammers; scale from the bolts as they are being forged drops on this slide, and together with the action of the water, results in excessive wear and disalinement of the lower hammer. The lever construction eliminates this wear. The side and top hammer slides in this design are operated by bronze bushed links in place of cams and rolls. The cam construction has been eliminated because of its excessive wear, and the fact that it promotes spring and lost motion in the hammer slides.



Yoke Construction of the Lever Carrying the Lower Hammer

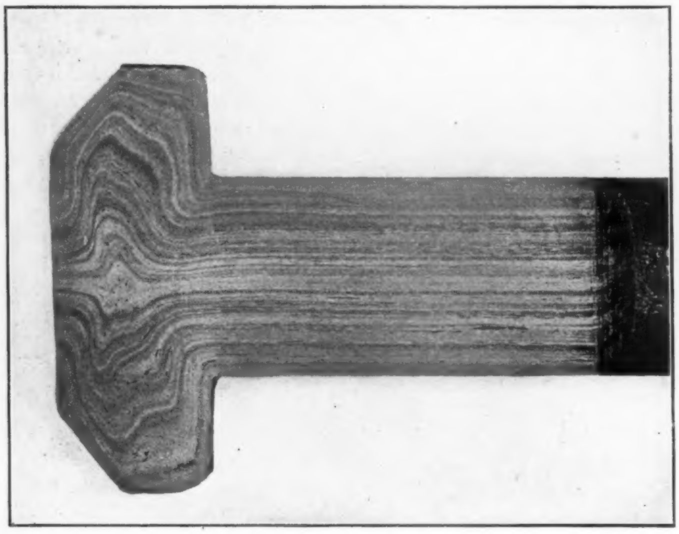
The fly-wheel is of the National friction-slip construction, which acts as an automatic safety device in case cold stock or an excess of metal is gripped in the dies and obstructs the travel of the heading tool. This fly-wheel also serves as a protection to the motor when the machine is direct motor driven.

The rigid construction combined with the mechanically operated grip makes it practicable to introduce a cut-off attachment in the gripping dies, so that short bolts can be made directly off the rod. Contrary to usual conditions, with this shear or cut-off in the grip dies short bolts are made with even more ease and facility than long bolts; four to six bolts may be made in one heat, depending somewhat upon the diameter of the stock and length of

the bolts. An automatic relief is also provided on the gripping mechanism to protect the machine against damage should the operator accidentally get stock or some foreign object in the grips in such a way as to prevent the dies from closing.

The slides in this machine have been made extra long, and bronzed bushed shaft bearings of large diameter have been used. The main shaft bearings are self-oiling and careful attention has been given to lubrication throughout; all oil cups or pockets are provided with hinged or sliding covers to exclude dust and scale.

The new continuous motion, semi-automatic machine is built in sizes of ¾ in., 1 in. and 1½ in. capacity, for either belt or motor drive. The rigidity of the construction has practically doubled the weight of these machines, as compared with others of similar rating; the one-inch header weighs approximately 13,000 lb. With this greater weight, however, the speed of the machine is high. The one-inch machine runs at 140 r. p. m. on its maximum work, which can be materially increased when running on smaller work.



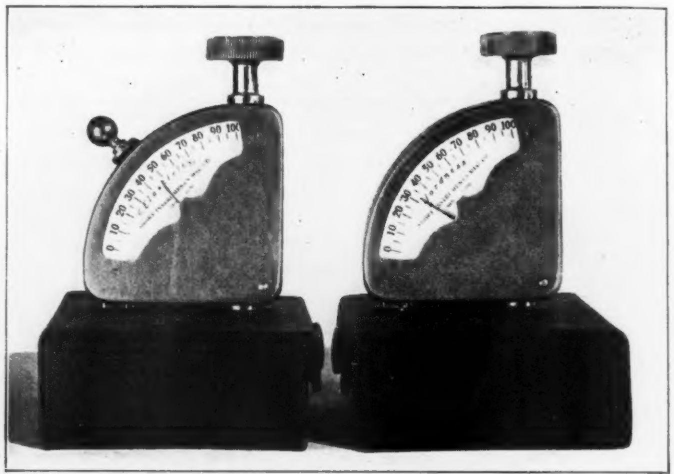
Etched Iron Bolt Made on the Continuous Motion Hammer Header Showing Unbroken Metal Fiber in the Head

INSTRUMENTS FOR MEASURING HARDNESS AND ELASTICITY OF RUBBER

In the manufacture of rubber goods, the process is not under economic control, such as is now common in metal production. It is not exactly known why in rubber working a pure raw material does not guarantee the finest finished article when subjected to a given heat treatment. When an article of fine quality is produced it has been impossible to tell without destroying it, just what the physical properties are which favor a given result and hence the manufacture goes on with no more enlightenment than before.

The two principal physical properties of rubber are hardness and elasticity, and instruments for the measurement and comparison of these have recently been brought out by the Shore Instrument & Manufacturing Company, 557 West Twenty-second street, New York. These instruments, shown with their leather pocket cases, are known as the durometer and elastrometer respectively and may be used either by hand or in connection with a small operating stand.

Hardness is measured by the durometer in terms of the resistance to depression of a plane surface by a standard spring pressing on a blunt pin. The surface of the rubber is not broken in any event, and it may therefore be used on finished articles. The elastometer measures elasticity in terms of resistance to permanent deformation or tearing under the action of a moderately sharp pin which is caused to penetrate the material. In applying the instrument the point is caused to penetrate the material by moving downward the knob on the side of the instrument. The relation of the edge of the point and the depth it is caused to penetrate, has been carefully determined by experiments on extremely elastic rubber. If the elasticity is quite perfect, no tearing or permanent injury results and the point will be completely ejected upon unlocking it by raising the knob. The extent of its ejection is shown on the scale of the instrument in per cent of the total penetration. The extent of the recovery of the material thus indicated corresponds to the percentage of elasticity as measured by the older form of stretch test. The new test has the advantage of being applicable to the plane surfaces of finished articles and leaves practically no visible mark.

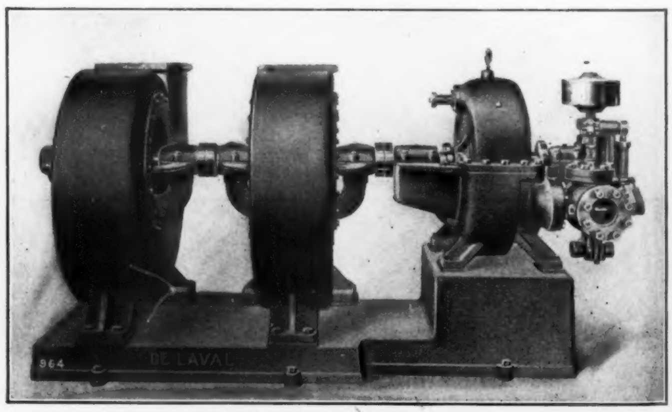


Elastometer and Durometer for Measuring Elasticity and Hardness of Rubber

These instruments are principally for the use of manufacturers of rubber to aid in economic production and the buyers of rubber goods in formulating purchase specifications and inspecting goods, as well as for research work.

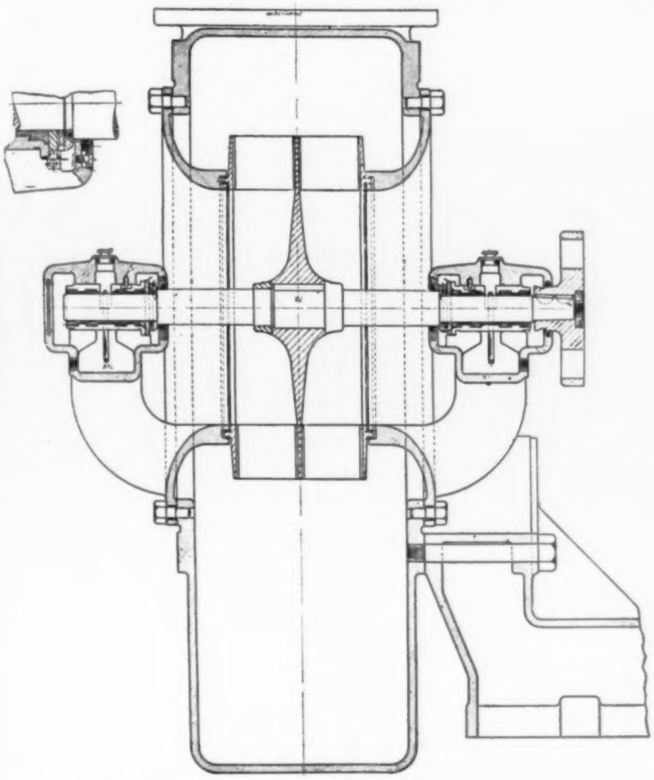
HIGH SPEED BLOWER AND CENTRIFUGAL AIR COMPRESSOR

Among the obvious faults of the usual type of paddle-wheel fan or blower is the shock with which the air is received by the impeller blades, the abrupt turns and sudden changes in cross-section of the passages through which the air flows. The supports for the floats or vanes obstruct the flow of the air, and the amount of surface in contact with the air moving at high velocities is large, resulting in considerable loss by skin friction. The



Two Single Stage Blowers Direct-Connected to a De Laval Velocity-Stage Turbine

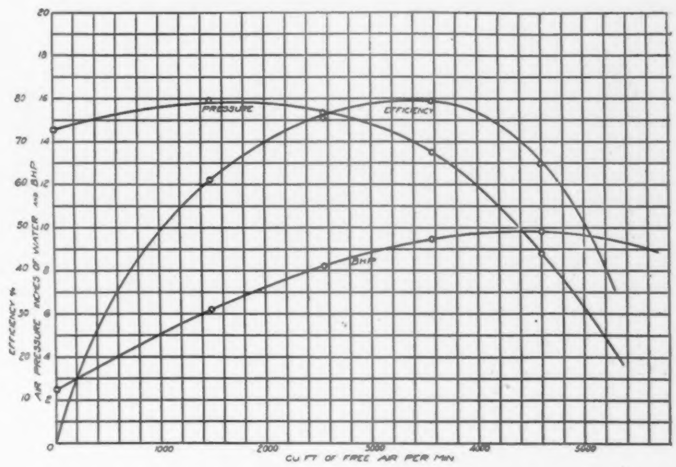
efficiency is low and the action noisy, and as ordinarily built, the fan is bulky, due to the slow speeds required because of structural weakness and lack of balance. The so-called multi-blade fans, which to some extent have replaced the paddle-wheel fan, run at still slower speeds for the same pressures and volumes. Neither type of fan is suited for direct connection to the modern high-speed rotative prime movers, such as the steam turbine and the electric motor. The DeLaval Steam Turbine Company, Trenton, N. J., by employing the same materials and workmanship used in building its turbines, has bound it possible to run centrifugal blower and compressor wheels safely at peripheral velocities of 450 to 600 ft. per second, rendering practicable the generation of 3 or 4 lb. pressure per sq. in. in a single-stage blower, and the connection of the blower or compressor directly to the turbine in nearly all cases.



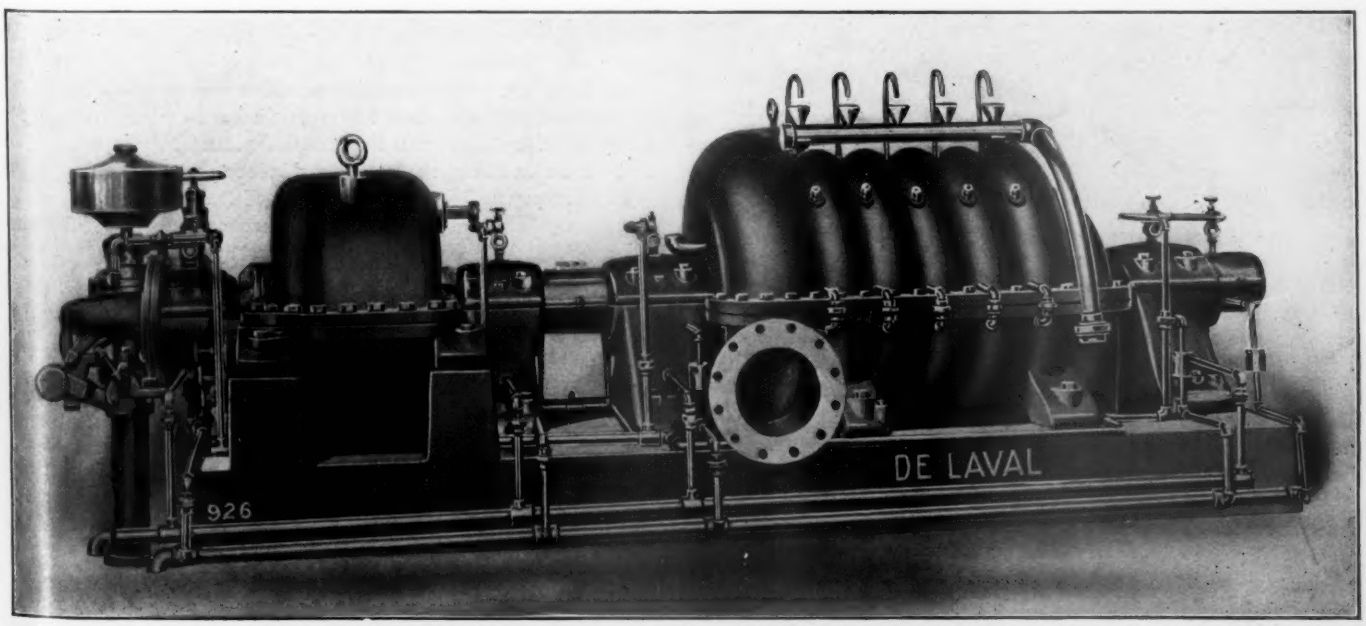
Sectional View of a Single Stage Double Suction Blower

The construction of a single-stage type of blower is shown in the sectional drawing. The housings of blowers of the double-suction type are in one piece, usually of cast iron. The bearing bracket is cast integral with a circular inlet ring or bell, fitting into the eye or opening of the casing, the opening being of sufficient diameter to permit removal of the impeller. The housing is so formed as to provide an efficient diffusor and volute, the discharge opening of which is provided with a flange for the attachment of piping. The bearings are of the vertically split babbitt-lined ring-oiled type, formed in separate shells resting in the brackets, or in exceptional cases, in pedestals.

The impeller is built up on a disc of heat-treated chrome-nickel steel, thickened at the center to form a hub, and also to turn the air which enters axially to a radial direction with the least shock. One side of each blade or vane is riveted directly to this disk, while the other is riveted to a steel side plate of the same material as the hub and also turned tapering to combine strength and lightness. The entrance edges of the blades are set at such an angle as to receive the air without shock and are formed to give the desired characteristics. Attached to the side plate is a ring which meshes with a corresponding groove in the inlet ring, thus forming a labyrinth packing which minimizes leakage from the discharge past the impeller back to the suction.



Characteristics of De Laval Single Stage Motor-Driven Blower



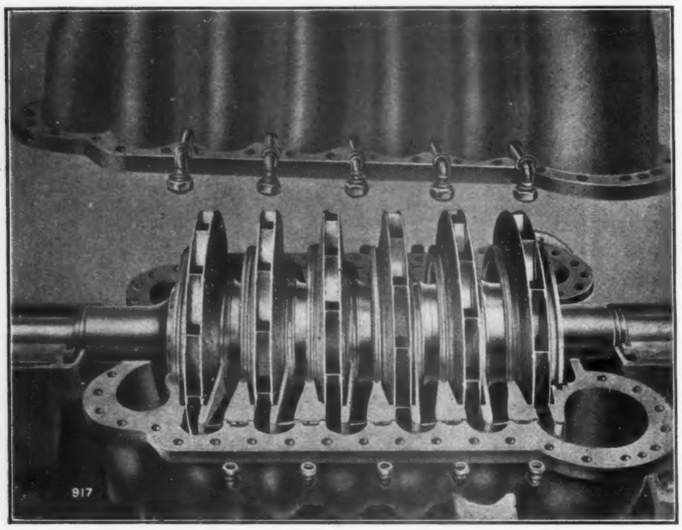
Six-Stage De Laval Centrifugal Air Compressor Driven by Multi-Stage Turbine

The shaft is made from special hammer-forged, open-hearth steel of a high tensile strength and uniform texture, ground in dead center grinders to insure absolute accuracy of dimensions, perfect centering and high finish.

These machines are employed for pressures ranging from four to six inches water column up to three to four pounds per square inch. The form of the head-delivery characteristic can be modified according to the work to be done.

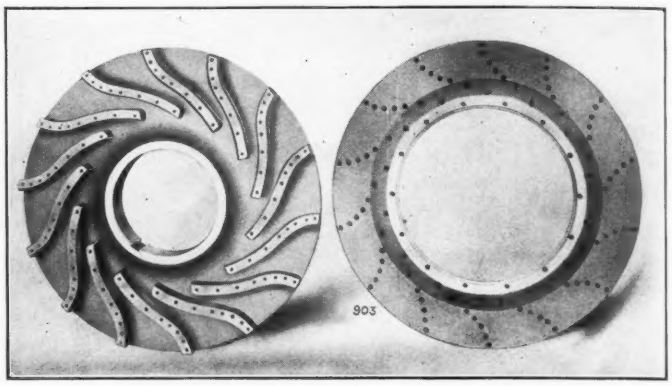
The casing of the multi-stage compressor is split horizontally, permitting the top half or cover to be lifted off so that internal parts may be inspected and lifted out after the removal of the bearing caps. The impellers are mounted upon a shaft of large diameter, the critical speed of which is far above the running speed. It is made from hammer-forged open-hearth steel, suitably heat treated and ground and polished over the entire surface on dead center grinders. The hubs of the impellers are keyed to the shaft and separated from one another by shaft tightening rings which run inside of split packing rings attached to the diaphragms in the stages. Where gases other than air are handled, double carbon rings are placed at each end of the casing, in addition to the labyrinth rings surrounding the impeller suction inlets and the packing rings on the shaft. The diaphragms between stages are separate from the casing and are divided on a horizontal plane so that they may be removed without removing the shaft and impellers. When cooling is employed, the diaphragms are hollow, the water entering through the bottom of the casing and escaping at the top.

The impellers are of the single-suction shrouded type, and are built up on heat-treated chrome-nickel steel disks, the blades or vanes being riveted to the disks and to side plates, turned tapering to give strength and lightness. That part of the disk which is within the circle of the suction opening is subjected on the inlet side to the suction pressure and on the back to the discharge pressure of the individual stage, which gives a resultant thrust equal to the area of the suction opening multiplied by the pressure generated. The accumulated thrust of all the stages is overcome by a balancing disk at the discharge end, so arranged that one side receives the total discharge pressure in a direction opposite to that acting upon the impeller disk, while the chamber upon the opposite side of the balancing disk is connected to the suction inlet, thus completely neutralizing the unbalanced pressure on all of the wheels.



Six-Stage Compressor with Top Casing Removed

As in the case of single-stage blowers, the head-delivery characteristic can be varied considerably to meet different requirements. Generally where compressed air is used in tools, a fairly constant pressure over a wide range of delivery is desired. The capacities in such cases range between 2,000 and 10,000 cu. ft. per min., and the pressures from 75 to 120 lb. per sq. in. Less than 2,000 cu. ft. per min. is usually not practicable. The larger machines for these pressures or machines which must run at motor speeds, are usually built in two sections, with separate shafts and housings, the speeds available with electric motors of these sizes requiring either a compressor with a large number of stages and several housings, or the use of a step-up gear, by which the compressor can be operated at 4,000 to 5,000 r. p. m.



Impeller Disc and Side Plate of Multi-Stage Air Compressor Showing Method of Attaching Vanes

Where either strictly constant head or strictly constant rate of delivery is required, speed variation or throttling of the suction is resorted to.

SAND BLASTING STEEL CARS

It has been a difficult problem in connection with the use of steel cars to clean the exterior in a satisfactory manner before painting. The use of acids for this purpose is not entirely satisfactory and this method is also dangerous for the workmen.

The matter of cleaning has assumed increased importance with the general advent of the steel passenger car, and where sand blasting has been adopted it seems to have been productive of remarkably good results.

The engravings show side elevation and sectional views of a sand blast installation which is in successful operation on a large system operating a great many steel cars in both passenger and freight service. The installation was designed by the Pangborn Corporation, Hagerstown, Md., who also manufactured and supervised the erecting of the equipment which is known as their model "P" car cleaning installation.

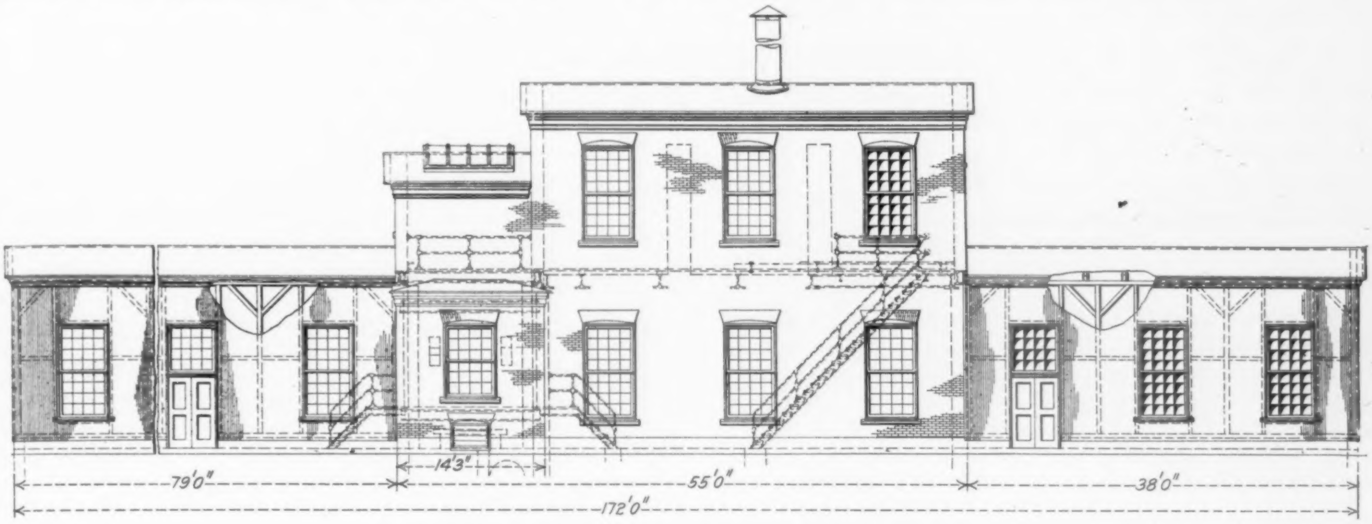
As shown in one of the illustrations the building is 172 ft. long, the main part being 55 ft. long and of brick construction, while the extensions are of wood and covered with corrugated steel sheathing. All the equipment is contained in the main part of the building; the sand blasting is done in a compartment 12 ft. by 17 ft. by 21 ft., and the dust is confined to this space. The end extensions keep the entire car indoors at all times.

Pits are provided, as shown in one of the sections, beneath the track on which the car stands and are covered with a grating 10 ft. wide. When new sand is necessary it is dumped on this grating and passes down the sloped sides of the pits to the elevators which are of the bucket type and which carry the new sand as well as that which falls from the sides of the car during the blasting operation, to the sand separators. These sand separators remove any refuse from the sand, the good sand passing into the sand bins and the refuse into the waste bins. From the sand bins the sand goes to the blasting machines which are operated by compressed air, the sand passing from the machine to a hose and nozzle in the hands of the operator who stands on the platform shown. Canvas curtains, as indicated on the drawings are arranged so that the section of the car standing over the grating is entirely enclosed.

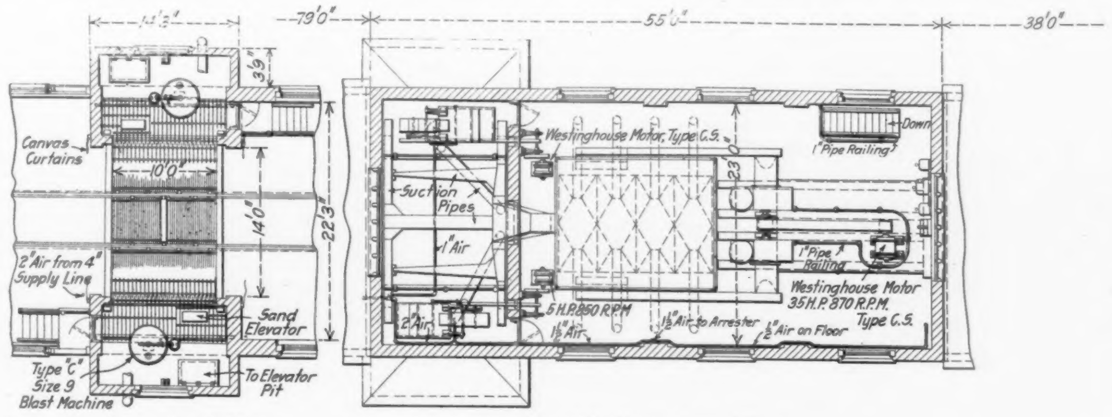
The engravings also clearly show the arrangement of the exhaust piping which is designed to remove the dust rapidly from

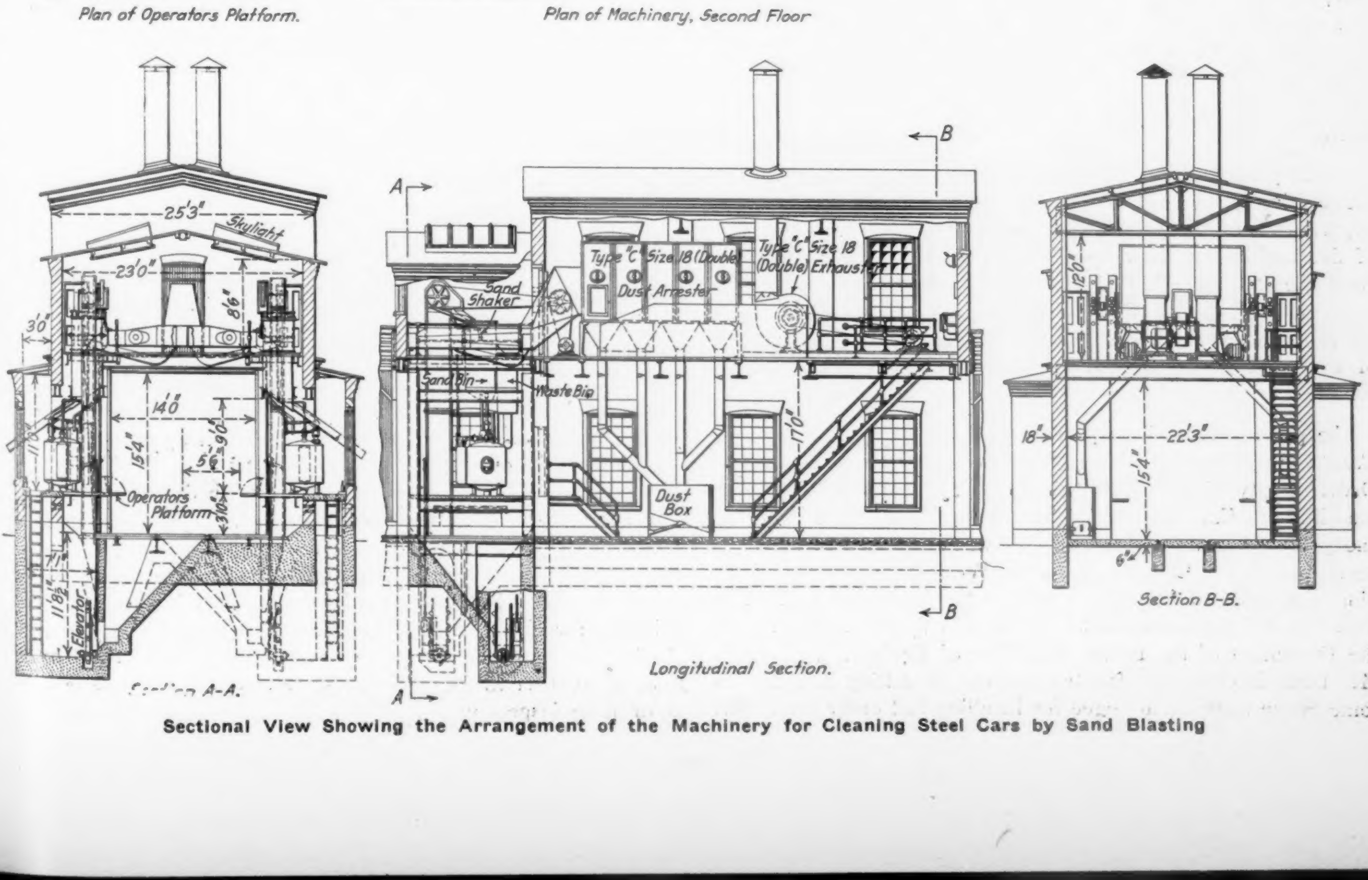
the enclosure when blasting is going on. The exhaust fan is double and is driven by a 35-hp. motor running at 870 r. p. m. The dust-laden air is exhausted into a dry process screen type dust arrester where the dust is completely separated. The dust is then delivered to dust boxes located on the first floor.

The elevating, separating and blasting machinery is in two units, one on either side of the car so that both sides can be cleaned at once. The sand separators and the elevators are driven by 5-hp. electric motors running at 850 r. p. m. Cars are hauled in and out of the building by an electric winch, built by the American Engineering Company, Philadelphia, Pa., and having a capacity of 6,000 lb. at a speed of 50 ft. per minute.



Side Elevation of the Building for Sand Blasting Steel Cars





Sectional View Showing the Arrangement of the Machinery for Cleaning Steel Cars by Sand Blasting

NEWS DEPARTMENT

The Brotherhood of Locomotive Engineers, at a convention recently held in Cleveland, adopted a resolution advocating a federal law requiring high-power headlights on locomotives on all steam railroads in the country.

The Pennsylvania Railroad has received word from the Panama-Pacific International Exposition at San Francisco that the company has been awarded the grand prize, the highest honor which could be conferred upon any railroad exhibiting.

The "Sunset-Central Boys' Educational Association" has been formed by officers of the Sunset Central Lines at Houston, Tex., for the purpose of organizing classes of office boys and messengers to study penmanship, arithmetic, typewriting and shorthand. Similar educational advantages are to be afforded to the young women employed by the company, of whom there are about 250 in Houston.

In the federal court at Jackson, Miss., June 15, a temporary injunction was granted restraining all district attorneys in Mississippi from prosecuting the Illinois Central and the Yazoo & Mississippi Valley for violating a headlight law passed by the legislature in 1912. The law stipulates that all locomotives operating on main lines in the state shall be equipped with high-power headlights. The case will be argued this month, when the roads will seek a permanent injunction.

The railroad department of the Young Men's Christian Association is establishing a railroad school in its recently completed college for the training of secretaries at Chicago. This course will be under the direction of leading railroad Y. M. C. A. secretaries, with W. N. Northcott, executive secretary of the railroad associations of Chicago, as dean. The purpose of the course is to train men to become efficient secretaries of railroad branches. This department of the school will begin its work next October.

Among the employees of the Pennsylvania Railroad retired on pension May 1 last was William Watson, staybolt inspector in the shops at Altoona, who had been in the service of the company 34 years and for over 20 years was inspector of flues in locomotives. A portrait of Mr. Watson is given in the bulletin issued by the company, and it is calculated that during his twenty years of service in this occupation he had crawled through the fire doors of 20,000 locomotives, and had inspected 6,440,000 flues.

A pamphlet entitled Railway Sanitation has been printed by the Baltimore & Ohio for circulation among employees in all departments of the service, for the general benefit. It consists of five articles on the subject by Dr. E. M. Parlett, re-printed from the Baltimore & Ohio Employees' Magazine. Dr. Parlett is a member of the General Safety Committee of the road. These essays include one dealing in detail with the sanitation of construction camps, and another on typhoid fever and its conquest.

The poem published on page 1377 of the *Daily Railway Age Gazette* of June 16, entitled "The Lament of the Foreign Bad Order Empty Car," which was ready by Secretary Taylor at the Master Car Builders' convention at Atlantic City as anonymous, was written by E. E. Betts, superintendent of transportation of the Chicago & North Western, and included by him in a series of bulletins issued to the members of the Chicago General Superintendents' Association by the committee on the Promotion of the Proper Handling of Equipment, of which Mr. Betts is chairman, for the purpose of calling attention to some of the methods in vogue for handling bad order cars. Mr. Betts says he is not so anxious about credit for his authorship as he is that somebody shall pay some attention to it. "It was reported as an amusing communication," he says, "all of which may be true. At the same time it was hoped that the moral would sink into some of our head mechanical men who would be aroused as to the necessity of taking some action to put a stop to the wanderings of the aforesaid foreign bad order empty cars."

SAFETY FIRST WORK ON THE NORFOLK & WESTERN

C. H. Blakemore, chairman of the safety commission of the Norfolk & Western, has issued a bulletin showing the decrease in injuries to employees during the 20 months ending December 31, 1914, since the safety movement was inaugurated on this road. The improvement with relation to the number of employees is shown on a chart on which is plotted a line showing the number of injuries and a line showing the fluctuations in the pay roll. The total pay roll and the total number of injuries as of May, 1913, is taken as a base line for making comparisons, and with relation to this line from August 1913 (the high point, with 463 accidents), to December, 1914, with 172 accidents, there was a decline of 70 per cent. From May, 1913, the lines showing pay roll and injuries gradually diverge and at the end of 1913 the pay roll had declined 7 per cent, while accidents had gone down 25 per cent. At the end of 1914 the pay roll had declined to 17 per cent below the base line, while accidents had gone down 58 per cent, a further gain in accident reduction of 41 per cent. When the safety movement was inaugurated one employee on the line was being injured for each $3,600 of pay roll. For December, 1914, one employee was injured for each $7,000 of pay roll.

CAUSE OF OAKWOOD (WIS.) DERAILMENT

The Interstate Commerce Commission has issued a report, dated April 28, on the derailment of a passenger train on the Chicago, Milwaukee & St. Paul at Oakwood, Wis., January 30, when 21 passengers were injured. The train was derailed at a crossover when running about 55 miles an hour, and Inspector H. W. Belnap concludes that the cause of the derailment was the breaking of a steel tired wheel on the middle of the right-hand side of a six-wheel truck at the front end of the baggage car. The wheel was of a built-up type with a cast iron spider, two rolled steel cheek plates and a rolled steel tire. The parts were held together by 39 bolts. The tire broke into four pieces and it was found that ruptures through the bolt holes had started, in each case, at the inner diameter of the tire, thence passing through the metal in an outward direction to the surface of the tire and through the flange. Considerable wear was found at the bearing between the plate and the tire. The mate of the broken wheel was taken apart and in it were found incipient cracks at each of the twelve bolt holes in the tire; and similar incipient cracks were found in other wheels examined. None of these cracks were visible until the outer circle of bolts was taken out or one of the plates removed. The broken wheel had not been overloaded. It had run 276,396 miles. The study of the broken wheel, and of others of the same type, was made by J. E. Howard, engineer. He concludes that tires of this type are sometimes loose, while yet the looseness is not detected by the ordinary inspections. His principal recommendation is for better inspection of the metal at the bolt holes, which means, of course, that wheels would have to be taken apart, as the cracks above referred to cannot be seen in an ordinary inspection.

MEETINGS AND CONVENTIONS

Master Car and Locomotive Painters' Association.—The forty-sixth annual convention of the Master Car and Locomotive Painters' Association will be held at the Hotel Statler, Detroit, Mich., September 14, 15, 16 and 17. The following subjects will be considered: Flat Color vs. Enamel Color; Effect of Steel Passenger Car Design on Protective Coating; Finish of Enamel or Varnish Color Compared with Varnish Finish; Piece Work; Maintenance of Inside of Steel Passenger Cars; Results of Price vs. Quality in Buying Paint Material.

International Railway General Foremen's Association.—The eleventh annual convention of the International Railway General Foremen's Association will be held at the Sherman Hotel, Chicago, July 13-16, 1915. Reports will be presented on the following subjects: Valves and Valve Gears, chairman, Walter Smith, Chicago & North Western; Rods, Ties, Wheels, Axles and Crank Pins, chairman, A. A. Masters, Delaware & Hudson; Shop Efficiency, chairman, George H. Logan, Chicago & North Western; Oxy-Acetylene Welding, chairman, F. A. Byers, St. Louis & San Francisco. A paper on the operation of a large engine terminal will be read by N. A. Whitsel, Chicago & Western Indiana. Shop and roundhouse foremen are urged to attend the convention and take part in the discussion.

American Railway Tool Foremen's Association.—At the annual convention of the American Railway Tool Foremen's Association which will be held at the Hotel Sherman, Chicago, July 19-21, 1915, the following topics will be discussed: Special Jigs and Devices in Locomotive Repair Shops; Safety First in Regard to Machinery and Tools; Special Tools and Equipment for Maintenance of Pneumatic Tools; Grinding and Distribution of Machine Tools in Locomotive Repair Shops, and Standardization of Reamers for Locomotive Repair Shops. This subject, which was taken up at the last convention, has been continued and each member of the association is requested to report on it at the coming convention. The selection of an emblem for the association will also be considered.

The following list gives names of secretaries, dates of next or regular meetings, and places of meeting of mechanical associations.

AIR BRAKE ASSOCIATION.—F. M. Nellis, 53 State St., Boston, Mass.

AMERICAN RAILROAD MASTER TINNERS, COPPERSMITHS AND PIPEFITTERS' ASSOCIATION.—W. E. Jones, C. & N. W., 3814 Fulton street, Chicago. Annual meeting, July 13-16, 1915, Hotel Sherman, Chicago.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.—J. W. Taylor, Karpen building, Chicago.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—Owen D. Kinsey, Illinois Central, Chicago. Convention, July 19-21, 1915, Hotel Sherman, Chicago.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth street, New York. Annual meeting, December 7-10, 1915, New York.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Sta., Chicago. Annual meeting, October, 1915.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 841 North Fiftieth Court, Chicago; 2d Monday in month, except July and August, Lytton building, Chicago.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—S. Skidmore, 946 Richmond street, Cincinnati, Ohio. Annual meeting, September 14-16, 1915, Richmond, Va.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—C. G. Hall, 922 McCormick building, Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1126 W. Broadway, Winona, Minn. Convention, July 13-16, 1915, Hotel Sherman, Chicago.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—A. L. Woodworth, Lima, Ohio. Convention, August 17, 1915, Philadelphia, Pa.

MASTER BOILER MAKERS' ASSOCIATION.—Harry D. Vought, 95 Liberty street, New York.

MASTER CAR BUILDERS' ASSOCIATION.—J. W. Taylor, Karpen building, Chicago.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOC. OF U. S. AND CANADA.—A. P. Dane, B. & M., Reading, Mass. Convention, September 14-17, 1915, Detroit, Mich.

NIAGARA FRONTIER CAR MEN'S ASSOCIATION.—E. Frankenberger, 623 Brisbane building, Buffalo, N. Y. Meetings monthly.

RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, Box C, Collinwood, Ohio.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, N. Y. C. & H. R., East Buffalo, N. Y. Convention, September 7-10, 1915, Hotel Sherman, Chicago, Ill.

PERSONALS

It is our desire to make these columns cover as completely as possible all the changes that take place in the mechanical departments of the railways of this country, and we shall greatly appreciate any assistance that our readers may give us in helping to bring this about.

GENERAL

W. M. BOSWORTH, mechanical engineer of the Louisville & Nashville, has been appointed mechanical engineer of the Norfolk Southern, with headquarters at Berkley, Va.

E. B. DE VILBIS, electrical engineer of the Pennsylvania Lines West, at Fort Wayne, Ind., has been appointed assistant engineer of motive power, with headquarters at Toledo, Ohio.

G. W. GOOD, formerly supervisor of piece work, New York Central, Lines West of Buffalo, has been appointed special representative, reporting to the general manager of the Michigan Central, with headquarters at Detroit. He will have entire charge of piece work in all departments, and will pass upon requests for new machinery.

B. B. MILNER has been appointed engineer of motive power of the New York Central, in charge of locomotive design and construction, and the relation of locomotive standards to operation, with headquarters at New York.

O. P. REESE, master mechanic of the Pennsylvania Lines West, with headquarters at Crestline, Ohio, and Pittsburgh, Pa., has been appointed assistant engineer of motive power, in the office of the general superintendent of motive power, succeeding T. R. Cook, resigned.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

F. F. CAREY, formerly a locomotive engineman of the Intercolonial Railway, has been appointed acting district master mechanic, District 3, at Moncton, N. B.

C. CONNORS has been appointed district master mechanic of district No. 1, Ontario division of the Canadian Pacific, at Toronto, Ont.

G. I. EVANS has been appointed district master mechanic, Ontario division of the Canadian Pacific, at Toronto, Ont.

J. W. FINDLAY has been appointed master mechanic of the Toronto division of the Canadian Northern at Parry Sound, Ont.

L. A. HARDIN, general foreman of the Chicago & North Western at Boone, Iowa, has been appointed assistant master mechanic at South Pekin, Ill.

A. H. MAHAN, locomotive foreman of the Grand Trunk Pacific at Prince George, B. C., has been appointed general locomotive foreman, with jurisdiction over territory from Prince George to Edmonton, Alta., including intervening branch lines.

J. F. MOFFATT, road foreman of engines of the Grand Trunk Pacific, with headquarters at Wainwright, Alta., has been appointed general locomotive foreman, with jurisdiction over territory from Transcona, Man., to Fort William, Ont., inclusive.

W. C. MOORE, formerly road foreman of engines of the Canadian Northern, has been appointed master mechanic of the Ottawa division at Trenton, Ont.

W. G. MCCONACHIE, road foreman of engines of the Grand Trunk Pacific, with headquarters at Edmonton, Alta., has been appointed general locomotive foreman, with jurisdiction over territory from Edmonton, Alta., to Watrous, Sask., including intervening branch lines.

M. B. MCPARTLAND has been appointed master mechanic of the Colorado and Nebraska divisions of the Chicago, Rock Island

& Pacific, with headquarters at Goodland, Kan., succeeding E. F. Tegtmeyer, resigned.

H. G. Ried has been appointed master mechanic of the Saskatchewan division of the Canadian Pacific at Moose Jaw, Sask., succeeding M. J. Scott, transferred.

M. J. Scott has been appointed master mechanic of the Alberta division of the Canadian Pacific at Calgary, Alberta, succeeding A. Sturrock, transferred.

H. R. Simpson, road foreman of engines of the Grand Trunk Pacific, with headquarters at Jasper, Alta., has been appointed general locomotive foreman, with jurisdiction over territory from Watrous, Sask., to Winnipeg, Man., including intervening branch lines.

W. H. Keller, who has recently been appointed master mechanic of the Baltimore & Ohio Southwestern at Cincinnati, Ohio, began railroad work on the Baltimore & Ohio as engine wiper in 1886. In the following year he became machinist apprentice on the Baltimore & Ohio at Keyser, W. Va., serving four years. He served as machinist at Keyser, at Cumberland, Md., and Grafton, W. Va., from 1891 to 1897. In that year he was appointed foreman at Jayenn, W. Va., and was later foreman at Wiston, W. Va., general foreman at Fairmont, W. Va., and later general foreman at Storrs. In 1912 he was transferred as general foreman from Storrs to Flora, Ill., and in 1914 was appointed division foreman of the Cincinnati, Hamilton & Dayton at Dayton, Ohio. In April, 1914, he was made acting master mechanic of the Cincinnati, Hamilton & Dayton at Indianapolis, and in February, 1915, was made assistant master mechanic at Cincinnati, which position he held when appointed master mechanic of the Indianapolis division of the Baltimore & Ohio Southwestern.

W. H. Keller

G. E. Sisco, who has been appointed master mechanic of the Toledo and Marietta divisions of the Central system of the Pennsylvania Lines West, began railway work in June, 1901, at the Fort Wayne shops of the Pennsylvania, Fort Wayne, Ind. At the end of the summer he returned to Johns Hopkins University, graduating in 1902, and again went to the Fort Wayne shops, this time as special apprentice. He was made foreman in 1906, and in September of the same year was transferred as foreman to the Allegheny shops. In June, 1910, he was appointed assistant master mechanic at the Allegheny shops. In January, 1912, he was made assistant engineer of motive power of the Southwestern system of the Pennsylvania Lines, with office at Columbus, Ohio, holding this position until his appointment as master mechanic.

A. Sturrock has been appointed master mechanic of the British Columbia division of the Canadian Pacific at Vancouver, B. C., succeeding D. T. Main, promoted.

A. Watt, general foreman of the Grand Trunk Pacific at Prince Rupert, B. C., has been appointed general locomotive foreman, with jurisdiction over territory from Prince Rupert to Prince George, B. C.

Frank W. Wilmore has been appointed assistant road foreman of engines of the Pennsylvania Lines West of Pittsburgh, with headquarters at Fort Wayne, Ind., succeeding Robert J. Lyons, assigned to other duties at his own request.

CAR DEPARTMENT

P. Alquist, superintendent of the car department of the Missouri, Kansas & Texas at Sedalia, Mo., has been appointed general superintendent of the car department, with headquarters at Dennison, Tex.

W. Forrest has been appointed car foreman of the Canadian Pacific at Megantic, Que.

W. H. Long, formerly general car foreman of the Canadian Northern at Toronto, Ont., has been appointed division car foreman of the Ottawa division at Trenton, Ont.

W. F. Miller has been appointed division car foreman of the Toronto division of the Canadian Northern at Parry Sound, Ont.

William Walker, general foreman of the Sedalia shops of the Missouri, Kansas & Texas, has been appointed superintendent of the car department at Sedalia, Mo., succeeding P. Alquist, promoted.

SHOP AND ENGINE HOUSE

W. H. Archer has been appointed locomotive foreman of the Grand Trunk at Palmerston, Ont., succeeding J. A. Walton, transferred.

Roy W. Band, formerly superintendent of shops of the Boston & Maine at Concord, N. H., has been appointed general mechanical shop inspector at Boston, Mass., and will report to the superintendent of motive power.

D. W. Hay has been appointed locomotive foreman of the Grand Trunk Pacific at Prince George, B. C., succeeding A. H. Mahan, promoted.

J. A. Miller has been appointed locomotive foreman of the Grand Trunk Pacific at Endako, B. C., succeeding G. H. Laycock, transferred to Jasper, Alta.

PURCHASING AND STOREKEEPING

C. D. French has been appointed storekeeper of the Canadian Northern at Humboldt, Sask., succeeding S. K. Moorcroft, promoted.

A. E. Hutchinson has been appointed general purchasing agent of the Oregon Short Line, with headquarters at Salt Lake City, Utah, succeeding G. H. Robinson.

S. K. Moorcroft has been appointed division storekeeper of the Canadian Northern at Saskatoon, Sask., succeeding A. E. Down, resigned to enter military service in Europe.

G. H. Robinson has been appointed general storekeeper of the Oregon Short Line at Pocatello, Idaho, succeeding T. A. Martin, promoted.

OBITUARY

Charles Hayward, formerly purchasing agent of the Chicago & North Western, died in Chicago, on June 13, at the age of 77 years. Mr. Hayward was born on October 15, 1837, entered railway service in 1879 with the Chicago & North Western, and was purchasing agent for many years.

M. E. Sherwood, division master mechanic of the Michigan Central, at Jackson, Mich., was accidentally shot and killed at that place on June 4. He was 46 years of age.

N. A. Waldron, general storekeeper of the Missouri, Kansas & Texas, with headquarters at Parsons, Kan., died in St. Louis, Mo., on May 30.

Supply Trade Notes

F. W. McIntyre, for the past four years connected with the Chicago office of the Niles-Bement-Pond Company, has been transferred to the Boston office, where he was formerly located.

George C. Wilson, of the Independent Pneumatic Tool Company, Chicago, has been appointed manager of that company's branch at Atlanta, Ga., succeeding F. H. Charbono, who has been transferred to Boston.

The Safety Car Heating & Lighting Company, New York, has been awarded a gold medal by the International Jury of Awards at the Panama Pacific International Exposition for its "Underframe" car lighting electric equipment.

C. H. Morse, Jr., has been elected president of Fairbanks, Morse & Company, succeeding his father, C. H. Morse, Sr. He is 41 years and was graduated from the University of Michigan in 1895, as a mechanical engineer. He first entered one of the Fairbanks, Morse & Company shops in order to get a practical knowledge of the building of gas engines, pumps, etc. He has been president of the Fairbanks, Morse Manufacturing Company, Beloit, Wis., in charge of manufacturing, for ten years, which position he still holds. He has also been a director of Fairbanks, Morse & Company, Chicago, for 15 years, a director of Fairbanks, Morse Electrical Manufacturing Company, Indianapolis, Ind., for eight years. Eight years ago Mr. Morse was also elected a director of the Canadian Fairbanks, Morse Company. C. H. Morse, Sr., the retiring president of Fairbanks, Morse & Company, was born in St. Johnsbury, Vt., in September, 1833. He began his business career at the age of 17, when he became clerk in the office of E. & F. Fairbanks & Co., scale manufacturers. In 1862 he became a member of the firm of Fairbanks, Greenleaf & Co., successors to E. & F. Fairbanks & Co. In 1872 the firm of Fairbanks, Morse & Co. was established, Mr. Morse, Sr., being elected president, which position he held until May '9, when he resigned.

C. H. Morse, Jr.

R. M. Newbold, formerly with the Adams & Westlake Company, has been appointed western manager of the railroad department of the Willard Storage Battery Company, succeeding P. D. Smith, who has resigned to accept service with another company.

The Kincaid Stoker Company, Cincinnati, Ohio, has been incorporated, with $50,000 capital stock, to manufacture mechanical stokers for use on locomotives, ships and in power plants. John Kincaid, Napoleon DuBrul, D. S. DuBrul and Clarence DuBrul are the incorporators.

Richard S. Brown, formerly a salesman of railway apparatus, connected with the Boston office of the Westinghouse Electric & Manufacturing Company, died in New York June 5. Mr. Brown was 76 years of age and had been in the service of the Westinghouse company since 1890.

H. C. Crawford, eastern traffic manager of the Cambria Steel Company at Philadelphia, has been appointed traffic manager of that company, succeeding William A. Sproul, who has resigned, effective August 1, after 25 years of service with the company, to take charge of the bureau of transportation and traffic of the Philadelphia Chamber of Commerce.

H. M. Montgomery has been elected vice-president and a director of the Powdered Coal Engineering & Equipment Company, Chicago. This company is preparing elaborate plans for the construction and equipment of a plant and research laboratory in Chicago, where working demonstrations of the adaptation of powdered coal as a fuel to all forms of heat production will be carried on, including its adaptability to locomotive service.

The Ingersoll-Rand Company, New York, on June 1 opened a new branch office at 139 Townsend street, San Francisco, Cal., with a view to giving closer attention to the needs of present and prospective users of Ingersoll-Rand machinery. H. L. Terwilliger, president of Harron, Rickard & McCone, the present Ingersoll-Rand agents, has resigned from that position to become district manager of the territory handled by the Ingersoll-Rand Company's San Francisco and Los Angeles offices, with headquarters in the former city. H. G. Mitchell, formerly secretary of Harron, Rickard & McCone, has been elected president of that company, succeeding Mr. Terwilliger, and arrangements have been made whereby the company will continue to handle Ingersoll-Rand machinery and co-operate in other ways with the Ingersoll-Rand Company after the expiration of the agency contract on July 22.

Harrison G. Thompson, a vice-president, and manager of the railway department of the Edison Storage Battery Company, Orange, N. J., has been appointed general sales manager and as such will have charge of all sales including the railway, house lighting and commercial departments. Mr. Thompson has been in the service of the Edison Storage Battery Company since July, 1910, becoming a vice-president in July, 1913. He was born at Weston, Mass., in 1875. In 1896 he entered the service of the Pullman Company and after having been with that company for two years was made foreman of electricians. In 1900 he resigned to become foreman of the battery department of the Riker Motor Vehicle Company, but left the latter at the time of its absorption by the General Vehicle Company of Hartford, Conn., to become associated with W. L. Bliss, one of the pioneers in electric car lighting development. In 1905 he entered the service of the Pennsylvania Railroad and was placed in charge of electric car lighting with headquarters at Jersey City, N. J. About one year later he became electrical superintendent of the Safety Car Heating & Lighting Company, New York, and was in charge of that company's electrical laboratories during the development of its first electric car lighting system. In December, 1909, he was appointed manager of the railroad department of the Westinghouse Storage Battery Company and later for a short time was in the employ of the United States Light & Heating Company, New York. In July, 1910, he became manager of the railway department of the Edison Storage Battery Company.

H. G. Thompson

The Chambers Valve Company, New York, announces that among other recent orders, it has received orders for Chambers throttle valves for installation on 42 locomotives of the Missouri, Kansas & Texas, 55 of the Chicago, Burlington & Quincy, 15 of the Western Maryland, 12 of the New York, Ontario & Western, and 2 of the El Paso & Southwestern.

The Harvey Company, 113 South street, Baltimore, Md., has recently been incorporated under the laws of Maryland to sell equipment and supplies to railroads, contractors, shop and engine building companies, etc. J. Edward Harvey, who has been elected president of the new company, was formerly vice-president of the South Baltimore Steel Car & Foundry Company, Baltimore, Md., and at one time proprietor of the Eastern Railway Supply Company.

Merton A. Peacock has been appointed district sales manager of the Terry Steam Turbine Company, Hartford, Conn., for the territory included in Minnesota, North Dakota and South Dakota, with office at 400 Endicott building, St. Paul, Minn. This arrangement supersedes the previous selling agreement with the Robinson, Cary & Sands Company, St. Paul. The company has also appointed the Hawkins-Hamilton Company, Peoples National Bank building, Lynchburg, Va., as its representatives for Virginia.

Benton C. Rowell, an inventor of numerous mechanical devices for use in railroad operation, and one of the most prominent advocates of automatic train control, died suddenly of heart failure on May 29 at Chicago, aged 58 years. He had made practically a life study of automatic train control. In 1891 he demonstrated his safety stop on the Boston, Revere Beach & Lynn, and in 1893 on the Intramural Railway at the Chicago World's Fair. In 1893 and 1894 the device was installed on the Chicago South Side Elevated Railroad, and in 1894 and 1895 on the Metropolitan West Side Elevated Railroad at Chicago. It was also given a service test on the Chicago, Burlington & Quincy in 1908 and 1909. Mr. Rowell also had numerous patents pending on appliances connected with railroad signaling.

The business of the Wells Light Manufacturing Company, Jersey City, N. J., has been acquired by the Alexander Milburn Company, Baltimore, Md., manufacturers of high power portable lights and oxy-acetylene welding apparatus. Repair parts for Wells lights will be manufactured and supplied in the future by the Alexander Milburn Company from its Baltimore factory, and complete Wells oil lights will also be furnished where desired, in conjunction with the standard Milburn acetylene lights. The manufacture of Wells oil preheating burner outfits will be continued by the company and sold in connection with Milburn oxy-acetylene apparatus. The Wells lights and Wells preheating devices have been on the market for about 20 years, and have occupied a leading place among oil-burning equipment of their kind.

Guy E. Tripp, chairman of the Westinghouse Electric & Manufacturing Company, has been quoted as follows: "The Westinghouse Electric & Manufacturing Company has purchased the property and assets of the Stevens Arms & Tool Company and the Stevens-Duryea Automobile Company, and a company has been incorporated under the laws of Massachusetts to own and control these two properties. This company will be known as the New England Westinghouse Company, and all of its $2,000,000 capital stock is owned by the Westinghouse Electric & Manufacturing Company. The company has no bonded debt. These two companies were purchased by the Westinghouse as a result of the order for 1,000,000 rifles which we have taken from the Russian government. This large order will be filled entirely from the two Stevens companies that have been purchased. It is not the intention of the Westinghouse Electric & Manufacturing Company to make any alterations whatever to its present plants in connection with this rifle order. In other words, it is to be filled by companies which are thoroughly experienced in the manufacture of this class of product, so that there are few uncertainties in connection with the transaction."

CATALOGS

Headlights.—The Esterline Company, Indianapolis, Ind., has recently issued catalog 364 descriptive of Golden Glow incandescent headlights. These headlights are extensively used on street car and interurban railway lines, and are also built for both steam and electric locomotive service.

Oxygen by Water Electrolysis.—In a pamphlet entitled "Production of Pure Oxygen and Hydrogen," the International Oxygen Company of Newark, N. J., gives a description of its system of producing oxygen by water electrolysis. Several installations of this system are illustrated. The purity of the gases produced by this method is shown to be especially high.

Boiler Water Treatment.—The Bird-Archer Company, 90 West street, New York, has recently issued a 40-page pamphlet dealing with boiler maintenance and discussing its system of polarized metallic boiler chemicals for locomotive use. A portion of the book is devoted to a brief treatise on locomotive boiler maintenance prepared by a general boiler inspector.

Insulators.—In a recently issued 12-page pamphlet the Brookfield Glass Company, 2 Rector street, New York, gives a brief list of insulators and insulator pins forming a part of its line of these products. Complete dimensions and specifications are given for each item. A more extensive list of the products of this company is contained in its bulletin No. 56.

Locomotive Cranes.—The Ohio Locomotive Crane Company, Bucyrus, Ohio, has issued a 56-page catalog in which the construction of its line of locomotive cranes is set forth in detail. The catalog contains a large number of illustrations of detail parts as well as reproductions from a number of photographs showing cranes in service. Clearance diagrams of various types of cranes are also given.

Driving Box Lubricator.—A catalog just issued by the Franklin Railway Supply Company, New York, is devoted to the Franklin automatic driving box lubricator. It is illustrated with a large number of sectional drawings showing the construction of lubricators of various sizes and for different classes of service. The method of removing packing and replacing the cellar is clearly explained with illustrations.

Rustproofing.—In the April number of the Scientist, published by the Goheen Manufacturing Company, Canton, Ohio, considerable information is given regarding the waterproofing of concrete and the protection of steel and galvanized iron from rust. Records are given of a number of bridges on the Chicago, Milwaukee & St. Paul to which the carbonizing coating manufactured by this company has been applied.

Water Meters.—The Harrison Safety Boiler Works, Philadelphia, Pa., has issued engineering leaflet No. 18, dealing with the Cochrane V-notch weir, used in the Cochrane metering heater. This pamphlet is a reprint of two papers on the V-notch weir, showing the refinements essential to accuracy in investigating problems in hydraulics and the constancy of the V-notch weir when used under known conditions.

Locomotives.—The H. K. Porter Company, Pittsburgh, Pa., has recently issued the eleventh edition of its catalog devoted to steam locomotives. This is a book of over 150 pages, 8½ in. by 11 in., and is substantially bound in cloth. In addition to the usual catalog features dealing with a large variety of standard Porter locomotives, it contains a section devoted entirely to engineering information, tables and formulas, and another section containing tables and other useful information not usually found in print. The book is intended especially for engineers, superintendents and master mechanics of industrial plants, coal mines, logging roads, etc. Owing to the expense involved in the compilation of the data which the book contains, general distribution is being made at the price of $1 per copy.